GOVERNMENT OF MADHYA PRADESH,
URBAN ADMINISTRATION AND DEVELOPMENT DEPARTMENT

SPECIFICATIONS
(4 PARTS)

PART - 2
BUILDING, WATER SUPPLY, DRAINAGE
AND
SANITARY INSTALLATIONS

ISSUED BY
COMMISSIONER
Urban Administration and Development Department
Government of Madhya Pradesh, Bhopal
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Typical Drawing for Anti-termite constructions and close planking and strutting.

List of Bureau of Indian Standard Codes
1.0 DEFINITIONS

Anchorage: - Anchorage is a structure used to carry the lateral thrust of a wall. Ties to a series of concrete blocks or a continues RCC beams, vertical or battered piles, inclined rock or soil anchores are generally used for this purpose.

Bentonite: - A clay formed by alteration of volcanic ash and rich in montmorillonite clay mineral. Bentonite has exchangeable iron on the surface of particles. It swells in the presence of water and its suspension is thixotropic.

Borrow area: - The source of construction material required for earth and rock fill dam.

Burjis: Short pillars of brick/stone having top surface finished with cement plaster for marking.

Cleat: A short member of shoring and timbering which directly resists the downward movement of strut or wale.

Deadmen or Tell Tales: Mounds of earth left undisturbed in pits dug out for borrowing earth.

Formation or Profile: Final shape of the ground after excavation or filling up.

Foul condition: Filthy and unhygienic conditions where physical movements are hampered such as soil mixed with sewage or night soil.

Guide wall: - walls of shallow depth built on both sides of the centre line of a diaphragm wall to guide the grabbing or boring tool for trench making in order to prevent collapse of trench panels and contain Bentonite slurry.

Riprap: - It is the protection to the embankment material against erosion due to wave action, velocity of flow, rain wash, wind action, etc; provide by placing a protection layer of rock fragments or manufactured material. Riprap may be placed on slope either by hand or it may be simply dumped.

Sheathing: The vertical members of shoring and timbering which directly resist pressure from the side of a trench.

Sheet Pilling: A line of piles driven in the soil to create a barrier or retaining wall.

Strut: A transverse member of shoring and timbering which directly resist pressure from sheathing or wales.

Trenching: - Excavation for a panel carried out in situ. Use of drilling mud may be necessary to prevent collapse of sides.

Trench: Any excavation in the ground where the depth of the excavation exceeds the width.

Trufing: - It is cover of grass grown over an area to prevent erosion of soil particles by rain wash.

Wale: A longitudinal member of shoring and timbering which directly resists pressure from sheathing.
1.1 Carriage
1.1.1 According to the specification C.P.W.D carriage by animal and mechanical transport shall be reckoned in one km. unit. Distances of 0.5 km. or more shall be taken as 1 km. and distance of less than 0.5 km. shall be ignored. However, when the total lead is less than 0.5 km., it will not be ignored but paid for separately in successive stages of 50 meters subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km. by mechanical/animal transport. Carriage by manual labour shall be reckoned in units of 50 meters or part thereof.

1.1.2 Lead; all distances shall be measured over the shortest route. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-charge along With reasons in writing.

1.1.3 Lift: The vertical distance for removal with reference to the ground level. The excavation up to 1.5 meters depth below the ground level and depositing the excavated materials upto 1.5 meters above the ground level are included in the rate of earth work. Lifts inherent in the lead due to ground slope shall not be paid for.

1.2 ANTIQUITIES AND USEFUL MATERIALS
1.2.1 Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value obtained in excavation shall be delivered to the Engineer-in-Charge and shall be the property of local body (Municipal Corporation, Municipal Council, Nagar Panchayat).

1.2.2 Any material obtained from the excavation which in the opinion of the Engineer-in-Charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of local body (Municipal Corporation, Municipal Council, Nagar Panchayat).

1.3 PROTECTIONS
1.3.1 Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident.

1.3.2 The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.

1.3.3 Excavation shall not be carried out below the foundation level of the adjacent buildings until underpinning; shoring etc. is done as per the directions of the Engineer-in-charge, payment for which shall be made separately.

1.3.4 Any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains pipes, culverts, over head wires, water supply tines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

1.4 SITE CLEARANCE
Before the earth work is started, the site (area coming under cutting and filling) shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings etc. of girth up to 30cm measured at a height of one meter above ground level and rubbish removed up to a distance of 50 meters outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and leveled.

1.4.1 The trees of girth above 30 cm measured at a height of one meter above ground shall be cut only after permission of the Engineer-in-charge is obtained in writing. The roots of trees shall also be removed as specified in 6.1 payment for cutting such trees and removing the roots shall be made separately.
1.4.2 Existing structures/services such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes etc. within the site, shall be diverted/dismantled as per directions of the Engineer-in-Charge and payment for such diversion/dismantling works shall be made separately.

1.4.3 In case of archaeological monuments, structure etc. within or adjacent to the area, the contractor shall provide necessary fencing all round such monuments as per the directions of the Engineer-in-Charge/Concern Authority and protect the same properly during execution of works. Payment for providing fencing shall be made separately.

1.4.4 Lead of 50 m mentioned in the ‘Schedule of Quantities’ is the average lead for the disposal of excavated earth within the site of work. The actual lead for the disposal of earth may be more or less by 50 m for which no cost adjustment shall be made in the rates. Earth shall be disposed off at the specified location or as decided by the Engineer-in-Charge. The contractor has to take written permission about proper place of disposal of earth before the earth is disposed off, from Engineer-in-Charge.

1.5 JUNGLE CLEARANCE
Jungle clearance shall comprise uprooting of rank vegetation, grass, brushwood, shrubs, stumps, trees and saplings of girth upto 30 cm measured at a height of one meter above the ground level. Where only clearance of grass is involved it shall be measured and paid for separately.

1.5.1 Uprooting of Vegetations
The roots of trees and saplings shall be removed to a depth of 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower. All holes or hollows formed due to removal of roots shall be filled up with earth rammed and leveled. Trees, shrubs, poles, fences, signs, monuments, pipe lines, cable etc., within or adjacent to the area which are not required to be disturbed during Jungle clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable.

1.5.2 Stacking and Disposal
All useful materials obtained from clearing and grubbing operation shall be stacked in the manner as directed by the Engineer-in-Charge. Trunks and branches of trees shall be cleared of limbs and tops and stacked neatly at places indicated by the Engineer-in-Charge. The materials shall be the property of the local body (Municipal Corporation, Municipal Council, Nagar Panchayat). All unserviceable materials which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be removed up to a distance of 50 m outside the periphery of the area under clearance. It shall be ensured by the contractor that unserviceable materials are disposed off in such a manner that there is no likelihood of getting mixed up with the materials meant for construction.

1.5.3 Clearance of Grass
Clearing and grubbing operation involving only the clearance of grass shall be measured and paid for separately and shall include removal of rubbish upto a distance of 50 m outside the periphery of the area under clearance.

1.5.4 Measurements
The length and breadth shall be measured correct to the nearest cm and area worked out in square Meters correct to two places of decimal.

1.5.5 Rates
The rate includes cost of all the operation described above.
Note: Jungle clearance and clearance of grass are not payable separately for the earth work specified in surface excavation rough excavation (excavation over area in trenches for foundations and drains, for pipes cables etc, in all type of soil).

1.6 FELLING TREES
While clearing Jungle, growth trees above 30 cm girth (measured at a height of one meter above ground level) to be cut, shall be approved by the Engineer-in-Charge and then marked at site. Felling trees shall include taking out roots upto 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower. All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20 cm layers and compacted thoroughly so
that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in-charge.

1.6.1 Stacking and Disposal
Wood, branches, twigs of trees and other useful material shall be the property of the Government. The serviceable materials shall be stacked in the manner as directed by the Engineer-in-Charge up to a lead of 50m.
All unserviceable material, which in the opinion of Engineer-in-Charge cannot be used or auctioned shall be removed from the area and disposed off as per the directions of the Engineer-in-Charge. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

1.6.2 Measurements: - Cutting of trees above 30 cm in girth (measured at a height of one meter above level) shall be measured in numbers according to the sizes given below:
(a) Beyond 30 cm girth, up to and including 60 cm girth.
(b) Beyond 60 cm girth, up to and including 120 cm girth.
(c) Beyond 120 cm girth, up to and including 240 cm girth.
(d) Above 240 cm girth.

1.6.3 Rate: - The rate includes the cost involved in all the operations described above. The contract unit rate for cutting trees above 30 cm in girth shall include removal of stumps as well.

1.7 Record of initial level:
1.7.1 Level Book: The level books should be numbered, accounted for and handled like measurement book. The initial level shall be recorded in level book.

1.7.2 Preparatory Works:
Before starting the earth work, following steps should be taken.

1.7.2.1 Original ground levels should be recorded in the Level Book in the presence of the contractor or his authorized representative, and should be signed by him and the Departmental Officer who records the levels. All the local mounds and depressions should be indicated clearly in the drawing and the field Level Book and should be checked by the Assistant Engineer before the leveling work is started.

1.7.2.2 A suitable baseline should be fixed with permanent masonry pillars at distances not more than 150 meters to provide a permanent reference line for facilitating check work. The base lines should be entered in the Level Book with co-ordinates. These baselines should be maintained till final bill for the work has been made or as directed by the Engineer-in-charge.

1.7.2.3 While recording the levels, it should be ensured that the circuit is closed by taking final levels of the starting point or any other point, the R.L. of which was previously determined.

1.7.2.4 Plans showing initial levels, location of bench marks and reduced levels should be prepared and signed by both the parties and attached to the agreement/ work measurement book.

1.8 Test Check of the Levels
1.8.1 The Engineer in charge should exercise test check at least to the extent of 50%, and the Executive Engineer at least to the extent of 10% of the recorded measurements by the Site Engineer where the value of this item of work exceeds 10% of the tender acceptance power of the Assistant Engineer. In case of out sourcing for supervision, responsibility of checking will remain unchanged.

1.8.2 The test check of the levels should be carried out independently by each officer, and the readings should be recorded in the prescribed Level Book in red ink against the old levels which should be neatly scored out wherever necessary. If the test check carried out reveals serious mistakes in the original levels, these should be taken or re-taken and re-checked.

1.8.3 The test check carried out by an officer should be as representative as possible for the entire work done.

1.9 Large Scale Leveling Work
In case of large scale leveling work involving both cutting and filling, an accurate site plan should be
prepared before the work is commenced. The portions requiring cutting and filling shall then be divided into squares and corresponding squares into filling, which are complementary to the squares in cutting given the same number.

1.9.1 A table may be written upon the plan showing leads involved between the various complementary squares. This would form a lead chart for the work to be done.

1.9.2 Before the work of leveling is commenced, the lead chart shall be checked by the Assistant Engineer in the presence of the contractor or his authorized representative, and his signatures shall be obtained on the same. This should form an integral part of the contract and should be duly signed by both the parties before commencement of the work.

1.9.3 Import of Earth: In case of earth to be imported, the area from where the earth is to be imported, should be pre-determined wherever possible before the start of the work, and wherever feasible, the average lead should be worked out and stipulated in the tender. After this is determined. Initial levels of the area to be filled should be recorded. The levels should be properly checked during the progress of work and on completion.

1.10 SETTING OUT AND MAKING PROFILES
To serve as a bench mark a masonry pillar shall be erected at a suitable point in the area, which would be visible from all points in the area, to serve as a bench mark for the execution of work. This bench mark shall be constructed and connected with the standard bench mark as approved by the Engineer-in-Charge. Necessary profiles with strings stretched on pegs, bamboos or ‘Burjis/pillar’ shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labour and material for constructing bench mark, setting out and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or ‘Burjis’ and the bench mark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

1.10.1 As per direction of Engineer-in-Charge the ground levels shall be taken at 5 to 15 meters intervals in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a scale of 5 meters to one cm or any other suitable scale decided by the Engineer-in-Charge. North direction line and position of bench mark shall invariably be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge or their authorized representatives to authenticate, it before the earth work is started. The labour required for taking levels shall be supplied by the contractor at his own cost during the excavation to check the profiles.

1.11 CLASSIFICATION OF EXCAVATED MATERIAL OR STRATA
The classification of strata shall be done by engineer not below the rank executive engineer or by other engineer authorized by competent authority.

The earthwork shall be classified under the categories given below and measured separately for each category:

1.11.1 All kinds of soil: Any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete mud concrete and their mixtures which for excavation yields to application of picks, showels, jumper, scarifiers, ripper and other manual digging implements, is classified in the category of “All types of soils”.

1.11.2 Ordinary rock: Ordinary rock is any rock which can be quarried or spilt with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard latrite, hard conglomerate and un-reinforced cement concrete below ground level. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but this does not in any way entitles to claim extra for blasting.

1.11.3 Hard rock (requiring blasting) : Hard rock (requiring blasting) is any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level.

1.11.4 Hard rock (blasting prohibited): Hard rock requiring blasting as described in para 1.11.3 above
but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, use of rock hammers and cutters or any other agreed method.

1.12 BLASTING

1.12.1 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to blasting operation as per rules.

The contractor shall obtain license from the competent authority for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Act, as (amended up to date) and the Explosive Rules. The contractor shall purchase the explosives, fuses, detonators, etc. only from a licensed dealer. The contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The Engineer-in-Charge or his authorized representative shall have the right to check the contractor’s store and account of explosives. The contractor shall provide necessary facilities for this. The contractor shall be responsible for any damage arising out of accident to workmen, public or property due to storage, transportation and use of explosive during blasting operation.

1.12.2 Blasting Operations:

(i) Blasting operations shall be carried out under the supervision of a responsible authorized agent of the contractor (referred subsequently as agent only), during specified hours as approved in writing by the Engineer-in-Charge. The agent shall be aware with the rules of blasting. In case of blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint and shall be checked before blasting by the contractor’s agent. Bore holes shall be of a size that the cartridge can easily pass down.

(ii) The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular notch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the notch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

(iii) Maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

(iv) Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

(a) The contractor’s agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be placed in the misfired holes and fired, or

(b) The holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one.

(v) Before leaving the site of work, the agent of one shift shall inform the another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent. The Engineer-in-Charge shall also be
informed by the agent of all cases of misfires, their causes and steps taken in that connection.

1.13 General Precautions: During blasting operations proper precautions shall be taken for the safety of the persons.

For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 meters from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision and trained personnel shall be employed. Blasting shall not be done with in 200 meters of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

All procedures and safety precautions for the use of explosives drilling and loading of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081, safety code for blasting and related drilling operation.

1.14 Precautions against Misfire
The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose. If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material.

The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

If a misfire has been found to be due to defective fuse, detonator or dynamite, the entire consignment from which the fuse detonator or dynamite was taken shall be got inspected by the Engineer-in-Charge or his authorized representative before resuming the blasting or returning the consignment.

1.15 EXCAVATION IN ALL KINDS OF SOILS
1.15.1 All excavation manually or by mechanical means shall include excavation and ‘getting out’ the excavated materials. In case of excavation for trenches, basements, water tanks etc. ‘getting out’ shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases ‘getting out’ shall include depositing/disposing the excavated materials as specified. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

1.15.2 In firm soils, the sides of the trenches shall be kept vertical up to a depth of 2 meters from the bottom. For more depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 meters from the bottom. The excavation can also be done so as to give slope of 1:4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or side slopes or the soil shored up as per direction of Engineer-in-Charge. The contractor shall be responsible for obtaining clear instructions in writing from engineer in charge regarding the stepping, sloping or shoring to be done for excavation deeper then 2 meter.

1.15.3 The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment. In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming.

1.15.4 While in excavation for drain work precaution shall be taken to cut the side and bottom to the required shapes slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth grater then that the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth properly watered and rammed, where the drains are not
required to be pitched. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.

1.15.5 The excavation shall be done manually or by mechanical means as directed by Engineer-in-charge considering feasibility, urgency of work, availability of labour/mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment be made on this account.

1.16 EXCAVATION IN ORDINARY/HARD ROCK
All excavation operations shall include excavation and 'getting out' the excavated matter. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge or excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the item of excavation stating lead. During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.

1.16.1 Where in hard rock blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to the blasting operations. Blasting operations shall be done as specified in para 1.12 and chiseling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-in-Charge and nothing extra shall be payable for chiseling. Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiseling.

1.16.2 In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be generally adopted. Where blasting operations are not prohibited & it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Eng-in-Charge in writing but nothing extra shall be paid for this blasting. Blasting shall be done as specified in para 1.12.

1.16.3 In case of soil or ordinary rock if the excavation for foundations or drains is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge. The excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for leveling/bed concrete for foundations. Soft/defective spots at the bed of foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.

1.16.4 In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling with earth duly watered, consolidated and rammed in case of soil or ordinary rock.

1.16.5 In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own cost in case of soil or ordinary rock

1.16.6 Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to, excavation shall be measured to the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.

1.16.7 The excavation shall be done manually or by mechanical means as desired by Engineer-in-Charge considering feasibility, urgency of work, availability of labour/mechanical equipments and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor any extra payment will be made on this account.

1.17 SURFACE EXCAVATION
1.17.1 Excavations exceeding 1.5 m in width and 10 sqm. on plan but not exceeding 30 cm. in depth in all types of soils and rocks shall be described as surface excavation and shall be done as specified in para 1.15 and 1.16.
1.17.2 Measurements
The length and breadth shall be measured with a steel tape correct to the nearest cm. and the area worked out to the nearest two places of decimal in square meters.

1.17.3 Rate
Rates for earthwork shall include the following:-
1) excavation and depositing excavated material as specified
2) handling of antiquities and useful material as specified in para 1.2
3) protection as specified in para 1.3
4) site clearance as specified in para 1.4
5) setting out and making profiles as specified in para 1.5
6) forming (or leaving) dead – men or ‘Tell Tales’ in borrow pits and there removal after measurements
7) bailing out or pumping of rain water from excavation
8) initial lead of 50 meter and lift of 1.5 meter
9) Blasting operation for hard rock as specified in para 1.12.

Note:- No deduction shall be made from the rate if in the opinion of the Engineer- in-charge, operations specified in para 1.17.3 (2) to (8) are not required to be carried out on any account what so ever.

1.18 ROUGH EXCAVATION
Excavation for earth from borrow pits, cutting hill side slopes etc. shall be described as rough excavation and shall be done as specified in para 1.15 & 1.16.

1.19 EXCAVATION OVER AREA (ALL KINDS OF SOIL)
1.19.1 This shall comprise excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth. Excavation for basements, water tanks etc. Excavation in trenches exceeding 1.5 m in width and 10 sqm on plan.

1.19.2 Excavation shall be done as specified in para 1.15.

1.19.3 Measurements shall be as below.
The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured, correct to 5 mm, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic meters.

1.19.3.1 In case of open footings up to the depth of 1.5 meters, all-round excavation of 30 cm. beyond the outer dimension of footing shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

1.19.3.2 In case of open footings/Rafts at a depth of more than 1.5 meter, all-round excavation of 75 cm shall be measured for payment to make allowance for centering and shuttering. Additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.

1.19.3.3 In case the ground is fairly uniform and where the site is not required to be leveled, the Engineer-in-Charge may permit the measurements of depth of cutting or height of filling with steel tape, correct to the nearest cm. In case of borrow pits, diagonal ridges, cross ridges or dead-men, the position of which shall be fixed by the Engineer-in-Charge, shall be left by the contractor to permit accurate measurements being taken with steel tape on the completion of the work. Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on and the earth so removed is utilized in the work. In the latter case nothing extra will be paid for their removal as subsequent operation.

1.19.3.4 Where ordinary rock and hard rock is mixed. The measurement of the excavation shall be made as specified in para 1.19.3.1 and 1.19.3.2 the two kinds of rock shall be stacked separately and measured in stacks. The net quantity of the two kinds of rocks shall be arrived at by applying deduction of 50% to allow for voids in stacks. If the sum of net quantity of two kinds of rocks exceeds the total quantity of the excavated material, then the quantity for each type of rock shall be worked out from the
total quantity in the ratio of net quantities in stack measurements of the two types of rocks. If in the opinion of the Engineering-in-charge stacking is not feasible, the quantity of ordinary and hard rock shall be worked out by means of cross-sectional measurements.

1.19.3.5 Where soil, ordinary rock and hard rock are mixed, the measurements for the entire excavation shall be made as specified in 19.3.1 and 19.3.2 Excavated materials comprising hard rock and ordinary rock shall be stacked separately, measured, and each reduced by 50% to allow for voids to arrive at the quantity payable inter hard rock and ordinary rock. The difference between the entire excavation and the sum of the quantities payable under hard rock and ordinary rock shall be paid for as excavation in ordinary soil or hard soil as the case may be.

1.19.3.6 Where it is not possible or convenient to measure the depth of cutting by recording levels as specified in para 1.19.3.1 quantity of excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill as specified and the quantity of earth work so computed shall be reduced by 10% in case of consolidated fills and by 5% in case the consolidation is done by heavy mechanical machinery to arrive at the net quantity of excavation for payment. No such deduction shall, however, be made in case of consolidation by heavy mechanical machinery at optimum moisture content, or when the consolidated filling is in confined situations such as under floors.

1.19.3.7 Rates shall be as specified in para 1.17.3.

1.20 EXCAVATION OVER AREA (ORDINARY/ HARD ROCK)
1.20.1 This shall comprise excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth. (In basements, water tanks etc and in trenches).

1.20.2 Excavation shall be done as specified in para 1.1.6.

1.20.3 Measurements shall be done as specified in para 1.19.

1.20.4 Rates shall be as specified in para 1.17.3.

1.21 EXCAVATION IN TRENCHES FOR FOUNDATIONS AND DRAINS (ALL KINDS OF SOIL)
1.21.1 This shall comprise excavation not exceeding 1.5 m in width or 10 sqm on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

1.21.2 Excavation shall be done as specified in para 1.1.5.

1.21.3 Measurements shall be as specified in para 1.19.3.1.

1.21.4 Rates shall be as specified in para 1.17.3.

1.22 EXCAVATION IN TRENCHES FOR FOUNDATION AND DRAINS (ORDINARY/ HARD ROCK)
1.22.1 This shall comprise excavation not exceeding 1.5m in width or 10 sqm. On plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

1.22.2 Excavation shall be done as specified in para 1.1.5.

1.22.3 Measurements shall be as specified in para 1.19.3.

1.22.4 Rates shall be as specified in para 1.17.3.

1.23 EXCAVATION IN TRENCHES FOR PIPES, CABLES ETC. AND REFILLING.
1.23.1 This shall comprise excavation not exceeding 1.5 meter in width or 10 sqm in plan and to any depth trenches for pipes. Cables etc. and returning the excavated material to fill the trenches after pipes, cables etc. are laid and their joints tested and passed and disposal of surplus excavated material upto 50 m lead.

1.23.2 Width of Trench
(1) Upto one meter depth the authorized width of trench for excavation shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on
concrete bed/cushioning layer, the authorized width shall be the external diameter of pipe (not socket/collar) plus 25 cm or the width of concrete bed/cushioning layer whichever is more.

(2) For depths exceeding one meter, an allowance of 5 cm per meter of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical up to depth of 2 meters from the bottom. For depths greater than 2 meters, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two meters from bottom.

(3) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.

(4) Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding increase in the width of trench. Sloping or shoring to be done for excavation in soft, loose or slushy soils.

1.23.3 Excavation: Shall be done as specified in para 1.15 & 1.16

1.24 EXCAVATION IN WATER. MUD OR FOUL POSITION

1.24.1 All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required. Pumping shall be done directly from the foundation trenches or from a sump out side the excavation in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

Capacity and number of pumps, location at which the pumps are to be installed, pumping hours etc. shall be decided from time to time in consultation with the Engineer-in-Charge.

Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby. To prevent slipping of sides, planking and strutting may also be done with the approval of the Engineer-in-Charge.

1.24.2 Classification

The earth work for various classification of soil shall be categorized as under:

(a) Work in or under water and/or liquid mud: Excavation, where water is met with from any of the sources specified in para 1.24.1 shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the sub-soil water level in that area.

(b) Work in or under foul position: Excavation, where sewage, sewage gases or foul conditions are met with from any source, shall fall in this category. Decision of the Engineer-in-Charge whether the work is in foul position or not shall be final.

1.24.3 Measurement:-

1.24.3.1 The unit, namely, meter depth shall be the depth measured from the level of foul position/sub-soil water level and upto the centre of gravity of the cross sectional area of excavation actually done in the conditions classified in 1.24.2. Meter depth shall be reckoned correct to 0.1 m, 0.05 m or more shall be taken as 0.1 m and less than 0.05 m ignored. The extra percentage rate is applicable in respect of each item but the measurements shall be limited only to the quantities of earth work actually executed in the conditions classified in para 1.24.2.

1.24.3.2 In case earth work in or under foul position is also in or under water and/or liquid mud, extra payment shall be admissible only for the earth work actually executed in or under foul position.
1.24.3.3 Pumping or bailing out water met within excavations from the sources specified in 24.1 where envisaged and specifically ordered in writing by the Engineer-in-Charge shall be measured separately and paid. Quantity of water shall be recorded in kilolitres correct to two places of decimal. This-payment shall be in addition to the payment under respective items of earthwork and shall be admissible only when pumping or bailing out water has been specifically ordered by the Engineer-in-Charge in writing.

1.24.3.4 Planking and strutting or any other protection work done with the approval of the Engineer-in-Charge to keep the trenches dry and/or to save the foundations against damage by corrosion of rise in water levels shall be measured and paid for separately.

1.24.3.5 Bailing or pumping out water, accumulated in excavation, due to rains is included under respective items of earthwork and is not to be paid separately.

1.24.3.6 Rates
The rates for respective items described above shall include cost of all the operations as may be applicable.

1.25 EARTH WORK BY MECHANICAL MEANS
Earth work by mechanical means involves careful planning keeping in view site conditions i.e. type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should be accordingly selected. The earth moving equipment consists of excavating and transporting equipment.

1.25.1 Excavators
The excavators generally used at site are as follows:
(i) Dipper-shovel (ii) Backhoe (iii) Skimmer (iv) Dragline (v) Clamsheen

1.25.2 Tractor-based Equipment
It is a self-propelled crawler or wheeled machine used to exert a push or pull force through mounted equipment. It is designed either as attachments to normal tracked or wheeled tractors or as machines in which the earth moving attachments and the tractor are designed as a single integrated unit. A tractor, which is hydraulically operated, can be rigged as:
(i) Loaders: (ii) Tractor Shovel: (iii) Trench Digger (iv) Scraper (v) Bulldozer (vi) Angle-doozer

1.25.3 Transporting Equipment
This implies horizontal movement primarily but it can involve some vertical movement too.
(i) Dumpers: (ii) Vibratory Roller

1.26 FILLING
1.26.1 The earth used for filling shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish.

1.26.2 Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or ½ tonnes roller. Where specified, every third and top most layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 meter vibratory power roller shall be used to consolidate the filing unless otherwise directed by Engineer-in-charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.

1.27 Recording Measurements for Earth Leveling Work
1.27.1 Level Books: in case of leveling operations and earthwork, measurements are required to be recorded in level books in addition to Measurement Books. The Level Books should be numbered, accounted for and handled like Measurement Books.

1.27.2 Wherever filling is to be done, the earth from excavation shall be directly used for filling and no payment for double handling of earth shall be admissible. Filling of excavated earth shall be done as specified in para 1.26. In case of hill side cutting, where the excavated materials is thrown down the hill slopes, payment for filling excavated earth shall not be admissible.
Measurements shall be as specified in para 1.19.3

Rates shall be as specified in para 1.17.3

1.28 Refilling
Fitting in trenches shall be commenced soon after the joints of pipes, cables, conduits etc. have been tested and passed. The space all-round the pipes, cables conduits etc. shall be cleared of all debris, brick bats etc. Where the trenches are excavated in hard/ soft soil, the filling shall be done with earth on the side and top of pipes in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the excavated earth is used for filling. In case of excavation trenches in ordinary/ hard rock, the filling up to a depth of 30cm above the crown of pipe, cable, conduits etc. shall be done with fine material like earth, moorum or pulverized/ decomposed rock according to the availability at site. The remaining filling shall be done with boulders of size not exceeding 15cm mixed with fine material like decomposed rock, moorum or earth as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30cm. Excavated material containing deleterious material, salt peters etc. shall not be used for filling. Ramming shall be done with iron rammers where feasible and with blunt ends of crowbars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, Cables, Conduits etc. laid in the trenches.

1.28.1 Measurements
1.28.1.1 Trenches for pipes, cables, conduits etc. shall be measured in running meter correct to the nearest cm in stages of 1.5 m depth and described separately as under:

(a) Pipes, cables, conduits, etc. not exceeding 80 mm dia.
(b) Pipes, cables, conduits etc. exceeding 80 mm dia but not exceeding 300mm dia.
(c) Pipes, cables, conduits etc. exceeding 300 mm dia.

1.28.1.2 Where two or more categories of each work are involved due to different classification of soil within the same stage of trench depth or where the soil is soft loose or slushy requiring increase in the width of trench or sloping sides or shoring, trenches for pipes, cables, conduits, etc. shall be measured in cubic meter as specified in para 1.26. Extra excavation, if any, on account of collar/ socket of pipes shall neither be measured nor paid for separately.

1.28.1.3 Rates
The rate shall be as specified in para 1.17.3 & shall also include the cost of refilling & all other operations described above.

1.29 FILLING IN TRENCHES, PLINTH, UNDER FLOOR ETC.
1.29.1 Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, salt peters etc. shall not be used for filling. All clods & lumps of earth exceeding 8cm in any direction shall be broken or removed before the earth is used for filling.

1.29.2 The space around the foundations and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers not exceeding 20cm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches, in case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

1.29.3 Measurements
1.29.3.1 Filling Side of Foundations: The cubical contents of bed concrete leveling course and masonry/ concrete in foundations upto the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earth work to arrive at the quantity for filling sides of foundation. The quantity shall be calculated correct to two places of decimal.

1.29.3.2 Fining in Plinth and under Floors: Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre-measurement correct to the nearest cm and cubical
content worked out in cubic meters correct to two places of decimal.

1.29.4 Rates:- The rate includes cost of all the operations described above.

1.30 SURFACE DRESSING.
1.30.1 Surface dressing shall include cutting and filling up to a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30 cm measured at a height of one meter above the ground level and removal of rubbish and other excavated material up to a distance of 50 meters outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depression filled up to the required level with the excavated earth so as to give an even, neat and tidy look.

1.30.2 Measurements
Length and breadth of the dressed ground shall be measured correct to the nearest cm and the area worked out in square meters correct to two places of decimal.

1.30.3 Rates
The rates shall include cost of labour involved in all the operations described above.

1.31 EARTH WORK FOR MAJOR WORKS
1.31.1 Excavation shall be undertaken to the width of the Basement/Retaining wall footing including necessary margins for construction operation as per drawing or directed otherwise. Where the nature of soil or the depth of the trench and season of the year, do not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or cut slopes with or without steps, to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer. Measurement of plan area of excavation for payment shall only be permitted.

1.31.2 All the major excavation shall be carried out by mechanical excavator. No extra payment shall be made for that.

1.31.3 The contractor shall make at his own cost all necessary arrangements for maintaining water level, in the area where works are under execution low enough so as not to cause any harm to the work shall be considered as inclusive of pumping out or bailing out water, if required, for which no extra payment shall be made. This will include water coming from any source, such as rains, accumulated rain water, floods, leakages from sewer and water mains subsoil water table being high or due to any other cause whatsoever. The contractor shall make necessary provision of pumping, dredging bailing out water coming from all above sources and excavation and other works shall be kept free of water by providing suitable system approved by the Engineer-in-charge.

Sub-soil water table at work site is reported to be about approx. 6.5 m. below the general ground level as observed in the month of April. The water level is likely to rise up to 1 to 2 m. during rainy season. In order to avoid possibility of basement floor of main building being getting uplifted/damaged due to water pressure, the contractor shall lower the ground water table below the proposed foundation level by boring tube wells all around the proposed building using well point sinking method or any suitable method as approved by Engineer-in-charge. Sub soil water table shall be maintained at least 50 cm. below the P.C.C. level during lying of P.C.C. water proofing treatment, lying of basement raft and beams including filling of earth/sand under the basement floor. The water table shall not be allowed to rise above base of raft level until completion of outer retaining walls including water proofing of vertical surface of walls and back filling along the walls upto ground level and until the structure attains such height to counter balance the uplift pressure. However, the contractor should inspect the site and make his own assessment about sub-soil water level likely to be encountered at the time of execution and quote his rates accordingly. Rate of all items are inclusive of pumping out or bailing out water, if required. Nothing extra on this account whatsoever shall be paid to him. The sequence of construction shall be got approved by the Engineer-in-charge.

1.31.4 The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades including signs, markings, flags, lights and flagman, as necessary at either end of the excavation/embankment and at such intermediate points as directed by the Engineer-in-charge for proper identification of construction area. He shall be responsible for all damages and accidents caused due to negligence on his part.
1.31.5 The contractor shall provide suitable barricading with suitably painted single row of G.I. Sheets about 3' 0" wide (90 cms.) nailed or bolted with wooden poles spaced 2 to 3 meter apart and each pole 1.6 m to 2 m long 8cm. to 10cm. dia. The poles will be embedded in mobile iron pedestal rings suitably framed for giving stable support as per direction of the Engineer-in-charge. All management (including watch and ward) of barricades shall be the full responsibility of the contractor. The barricades shall be removed only after completion of the work or part of the work. The contractor’s rate shall include all above items of work and nothing extra shall be paid to the contractor over and above his quoted rates.

1.32 PLANKING AND STRUTTING

1.32.1 When the depth of trench in soft/loose soil exceeds 2 meters, stepping, sloping and/or planking and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken shall be determined by the Engineer-in-charge according to the nature of soil. Planking and strutting shall be ‘close’ or ‘open’ depending on the nature of soil and the depth of trench. The type of planking and strutting shall be determined by the Engineer-in-Charge. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches from collapse. Engineer-in-Charge should take guidance from IS: 3764 for designing the shoring and strutting arrangements and specifying the profile of excavation.

1.32.2 Close Planking and Strutting

Close planking and strutting shall be done by completely covering the sides of the trench generally with short upright, members called ‘poling boards’. These shall be 250x38 mm in section or as directed by the Engineer-in-Charge.

The boards shall generally be placed in position vertically in pairs. One boards on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 meters cross strutted with ballies, or as directed by Engineer-in-Charge. The length and diameter of the ballies strut shall depend upon the width of the trench. Typical sketch of close timbering is given in Fig.10.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical ‘wallings’ which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed.

The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in-Charge to be left permanently in position.

1.32.3 Open Planking and Strutting

In case of open planking and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick shall be spaced sufficiently apart to leave unsupported strips of 50 cm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subject to the approval of the Engineer-in-Charge, in all other respect, specifications for close planking and strutting shall apply to open planking and strutting. Typical sketch of open planking and strutting is given in fig.10.

1.32.4 Measurements

The dimensions shall be measured correct to the nearest cm and the area of the face supported shall be worked out in square meters correct to two places of decimal.

1.32.4.1 Works shall be grouped according to the following:

(a) Depth not exceeding 1.5 m.
(b) Depth exceeding 1.5m in stages of 1.5 m.

1.32.4.2 Planking and strutting to the following shall be measured separately:

(a) Trenches.
(b) Areas- The description shall include use and waste of raking shores.
(c) Shafts, walls, cesspits, manholes and the like
(d) Where tightly driven close but jointed sheeting is necessary as in case of running sheeting Is
necessary as in case of running sand the item shall be measured separately and packing of cavities behind sheeting with suitable materials included with the item.

(e) Planking and strutting required to be left permanently in position shall be measured separately.

1.32.5 Rates
Rates shall include use and waste of all necessary timber work as mentioned above including fixing and subsequent removal.

1.33 ANTI-TERMITE TREATMENT
1.33.1 Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

1.33.2 Materials
1.33.2.1 Chemicals: Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:
(i) Chlorphriphos emulsifiable concentrate of 20%
(ii) Lindane emulsifiable concentrate of 20%

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. For example to dilute chemical of 20% concentration. 19 parts of water shall be added to one part of chemical for achieving 1 % concentration.

Engineer-in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers; chemical shall be kept in the custody of the Engineer-in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

1.33.2.2 Measurements: Concentrated chemical in sealed containers shall be measured in liters. Chemicals of different types and concentration shall be measured separately.

1.33.2.3 Rate: The Rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

1.33.3 Safety Precautions
Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapors or spray mists or swallowed. The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion. Workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe
contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

1.33.4 Anti-Termite Treatment: Constructional Measures
The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building.

(i) Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50 mm in brick masonry for providing apron floor around the periphery. [See Fig.1.3(i)]

(ii) Brick on edge masonry in cement mortar shall be laid on the plinth wall. Dry brick shall be placed on the inner side of plinth wall for getting anticipated offset space for coarse sand and on the other side for installing anti-termite masonry groove. In the case of intermediate walls, dry bricks are placed on either side of the brick on edge masonry for getting offset space for coarse sand layer. [See Fig. 1.3(ii)]

(iii) The dry brick for the anti-termite groove shall be taken out and dense cement concrete 1:3:6 (1 cement: 3 sand: 6 coarse aggregate by volume) sub-floor carpet shall be laid casting the anti-termite groove in position. In case of internal partition walls, the cement concrete sub-floor shall be laid on either side over the dry bricks to sufficient extent for getting staggered vertical joints over the joint of plinth wall and earth filling. [See Fig. 1.3(iii)]

(iv) Superstructure masonry shall be raised over the dense cement concrete sub floor carpet and Overhead jobs completed. [See Fig. 1.3(iv)]

(v) The dry brick for coarse sand layer shall be removed and graded sand (of size 3 to 5 mm) layer at least 100 mm thick shall be compacted over the earth filling and underneath the partially laid dense cement concrete sub-floor carpet. [See Fig. 1.3(v)]

(vi) Dense cement concrete (1:3:6 mix.) sub-floor at least 75 mm thick shall be laid over the sand filling. Necessary finish may be provided to the cement concrete sub-floor carpet. [See Fig. 1.3(vi)]

(vii) Dry brick provided for apron floor shall be taken out and 600 mm wide formation of earth in 1:30 slope shall be made. Over the formation, 75 mm thick lime concrete 1:3:6 (1 lime:3 sand: 6 coarse aggregate, by volume) shall be laid. [See Fig. 1.3(vii)]

(viii) Over the 75 mm thick like concrete bed at least 25 mm thick cement concrete topping 1:2:4 (1 cement: 2 sand: 4 fine aggregate, by volume) shall be laid and 12 mm thick cement plaster shall be applied on foundation and plinth. [See Fig. 1.3(viii)]

The final recommendations incorporating the constructional details given above (i to viii) are shown in Fig.

1.33.5 Anti Termite Treatment: Treatment for Existing Building: Post Construction Treatment

1.33.5.1 Material
(i) Chemicals: Any one of the following chemicals conforming to relevant Indian Standards in water emulsion may be used for soil treatment in order to protect a building from termite attack.

<table>
<thead>
<tr>
<th>Chemical with Percent</th>
<th>Relevant Indian Standards</th>
<th>Concentration by weight (Active ingredient)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorphriphos 20EC</td>
<td>IS 8944</td>
<td>1.0</td>
</tr>
<tr>
<td>Lindane 20EC</td>
<td>IS 632</td>
<td>1.0</td>
</tr>
</tbody>
</table>

These chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemicals should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration, 19 parts of water shall be added to one part of chemical for achieving 1% concentration. Oil or kerosene based solution of Chlorphriphos 20 EC or
Lindane 20 EC, 1.0 percent (by weight) concentration is useful for treatment of wood. Engineer-in-charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized representative. Chemical shall be kept in the custody of the Engineer-in-charge or his authorized representatives and issued for use to meet the day’s requirements. Empty containers after washing and concentrated chemical left unused at the end of the day’s work shall be returned to the Engineer-in-charge or his authorized representative.

(ii) **Measurements:** Concentrated chemical in sealed containers shall be measured in liters. Chemicals of different types and concentration shall be measured separately.

(iii) **Rate:** The rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

(iv) **Safety Precautions:** Chemical used for antitermite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons carrying out chemical soil treatments should familiarize themselves and exercise due care when handling the chemicals whether in concentrated or in dilute form. After handling the concentrates or dilute emulsion, worker shall wash themselves with soap and water and wear clean clothing especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

The use of chemical shall be avoided where there is any risk of wells or other water supplies becoming contaminated.

**1.33.5.2 Treatment**

(i) Once the termites have an ingress into the building, they keep on multiplying and destroy the wooden and cellulose materials, and as such it becomes essential to take measures for protection against termites. Anti termite measures described below are necessary for the eradication and control of termites in existing building. To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites in existing building shall be done as per IS 6313 (Part 111). Treatment shall be got done only from the approved specialized agencies using the chemical procured directly by the Engineer-in-Charge from reputed and authorized dealers.

(ii) **Treatment along outside of foundations:** The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 liters per square meter of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 liters per running meter of the channel. Roding with 12 mm diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 liter per running meter shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 liters per linear meter.

In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along
with external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 liters/sqm. of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams up to a depth of 300 mm or up to the bottom of the plinth beams, if this level is less than 300 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

(iii) **Treatment of Soil under Floors**: The points where the termites are likely to seek entry through the floor are the cracks at the following locations:

(a) At the junction of the floor and walls as result of shrinkage of the concrete;
(b) On the floor surface owing to construction defects;
(c) At construction joints in a concrete floor, cracks in sections; and
(d) Expansion joints in the floor.

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one liter per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

(iv) **Treatment of Voids in Masonry**: The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at 300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirited through the holes till refusal or to a maximum of one liter per hole. Care shall be taken to seal the holes after the treatment.

(v) **Treatment at Points of Contact of Wood Work**: The wood work which has already been damaged beyond repairs by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6 mm holes at a downward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a liter per hole. The treated holes shall then be sealed.

Infested wood work in chaukhats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3 mm diameter with a downward slant to the core of the wood work on the inconspicuous surface of the frame. These holes should be at least 150 mm centre to centre and should cover in entire frame work. Chemicals shall be liberally infused in these holes- If the wood is not protected by paint or varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

1.33.5.3 Measurements: All dimensions shall be measured correct to a cm. The measurements shall be made of the surface actually provided with anti termite treatment. Measurements shall be done separately for treatment of foundations, soils under floors, voids in masonry and wood work as detailed below:

(i) Treatment along outside of foundations: The measurements shall be made in running meters taking length along the plinth of the building. (ii) Treatment of soil under floors: The measurements shall be made in square meters, inside clear dimensions of rooms, verandah etc. shall be taken. (iii) Treatment of voids in masonry: The measurements shall be made in running meters along the plinth of the building. (iv) Treatment of wood work: The measurements shall be made in running meters for chaukhats, joints, purlins, beams etc.

1.33.5.4 Rates
The rate shall include the cost of labour and all other inputs (except concentrated chemical) involved in
all the operations described above including drilling, refilling and making good the holes.

1.33.5.5 Treatment of Electrical Fixtures
If infestation in electrical fixture (like switch boxes in the wall) is noticed, covers of the switch boxes shall be removed and inside of such boxes shall be treated liberally with 5 per cent Malathion dusting powder. The covers of the switch boxes shall be refixed after dusting.

(i) On completion of work, the levels should again be recorded in the Level Book and the contractor’s signatures obtained. These levels should also be test checked by the Assistant Engineer/Executive Engineer to the same extent as indicated in 1.8 within one month of the date of completion of the earth work, and according to the procedure as laid down in the case of initial levels as indicated above.

(ii) The formation levels as per final execution of the work should be compared with the proposed formation levels and the work got rectified within permissible tolerance.

1.34 Payment of Leveling Work
(1) Every fourth running bill and the final bill should be paid on the basis of levels.
(2) Intermediate payments can, however, be made on the basis of borrow pit measurements. The Executive Engineer should take care that the quantities thus assessed are not in any case more than the actual work done.
(3) The quantity payable for earthwork shall be lower of the quantity derived from cutting or filling. The payment for lead shall be based on lead chart prepared in the aforesaid manner.

Anti-Termite Construction – Stage – 1

Anti-Termite Construction – Stage – 2
Anti-Termite Construction – Stage - 3

Anti-Termite Construction – Stage - 4
Anti-Termite Construction – Stage - 5

Anti-Termite Construction – Stage - 6
Anti-Termite Construction – Final Recommendations
### IST OF BUREAU OF INDIAN STANDARD CODES

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<th>Subject</th>
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2.0 MORTARS
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Definitions

**Admixture:** - A material other than water, aggregates and hydraulic cements used as an ingredient of concrete or mortar and added to be batch immediately before or during its mixing to modify one or more of the properties of the concrete in the plastic or hardened state.

**Composite Mortar:** - A mortar contains cement and lime in addition to other ingredient.

**Consistency:** - The working consistency of a mortar or plastering mix as judged by the worker forms its behavior during application. Its assessment includes characteristics, such as initial fluidity, Water receptivity, etc.

**Fat line:** - Can not be a pure non hydraulic lime. It may be in quick hydrated or putty form.

**Slaking:** - Slaking usually means addition of the requisite amount of water to quick lime so as to far dry slaked lime putty or slurry.

**Popping or Putty:** - A typed of unsoundness caused by particle of unhydrated or incompletely hydrated lime which hydrate and expand at some period subsequent to actual use; it manifests itself in the form of craters or blisters on plaster surfaces.

**Pozzolana:** - An essentially siliceous material which while in itself possesses no cementitious properties will in finely divided form and in the presence of water react with calcium hydroxide at ordinary temperature to form compounds possessing cementations properties.

**Natural sand:** - Fine aggregates resulting form the natural disintegration of rock and which have been deposited by streams or glacial agencies.

**Water Retain ability:** - The ability of mortars to retain water against suction and evaporation in general. It is indirectly a measure of the workability of mortar. It is measured by the flow of mortar when tested on a standard flow table before application of specified suction.
2.0 GENERAL: - Mortar is used in building and other work. The desirable properties of mortars for use in masonry are:-
(a) Workability
(b) Water retentively
(c) Rate of stiffing
(d) Strength
(e) Resistance to rain penetration
(f) Durability

2.1 MATERIALS
The material used in mortar is water, cement, fine aggregate (sand or broken bricks) and fly ash.

2.1.1 Water
Water is an important component of mortar. The mandatory test required for water is as below:-
(A) Required Test :- (i) pH Value (ii) limit of acidity (iii) limits of alkalinity (iv) Percentage of solids: -
(a) chlorides (b) suspended maters (c) Sulphates (d) inorganic solids (e) Organic solids

(B) Field/laboratory test and test procedure: - all laboratory test shall be as per IS 3025

(C) Frequency of testing: - water from each source shall be got tested before the starting of work and thereafter once in every three months till the completion of work. Water from municipal source need to be tested only once in six month. Number of tests for each source shall be 3.

2.1.1.1 QUALITY OF WATER
Water used for mixing and curing shall be cleaned and free from injurious quantities of alkalis, acid, oils, salts, sugar, organic materials, vegetable growth or other substance that may be dataries to bricks, stone, concrete, or steel. Portable water is generally considered satisfactory for mixing. The pH Value of water shall be not less than six the following concentrations represent the maximum permissible values (of deleterious material in water).

(a) Limits of Acidity: To neutralize 100ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The details of test shall be as given in IS 3025 (part 22).

(b) Limits of Alkalinity: To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H2SO4. The details of tests shall be as given in IS 3025 (part 23).

(c) Percentage of Solids: Maximum permissible limits of solids when tested in accordance with IS 3025 shall be as under:
- Organic 200mg/ liter
- Inorganic 3000 mg/ liter
- Sulphates 400 mg/ liter
- Chlorides 2000 mg/ litre for concrete not are containing embedded steel and 500 mg/ltr for reinforced concrete work.
- Suspended matter 2000 mg/ liter

2.1.1.2 The physical and chemical properties of ground water shall be tested along with soil investigation.

2.1.1.3 Water found satisfactory for mixing is also suitable for curing. However, water used for curing shall not produce any objectionable stain or unsightly deposit on the surface.

2.1.2 Cement
Cement is a main component of mortar. The mandatory tests required for cement are as below:-
(A) Required test of cement :- (a) Physical requirement
- (i) Fineness (ii) soundness (iii) setting time (initial and final) (iv) compressive strength
- (v) consistency of standard cement paste.

(B) Field/ laboratory test and test procedure: - All above laboratory test are as per IS 4031 (PART II, III, V, VI)
(C) Frequency of testing: - from each lot, every 50 tones or part thereof. Each brand of cement brought to site shall be tested as this frequency:-

2.1.2.1 The cement used shall be any of the following grades and the type selected should be appropriate for the intended use.
(a) 33 grade ordinary Portland cement conforming to IS 269.
(b) 43 grade ordinary Portland cement conforming to IS 8112.
(c) 53 grade ordinary Portland cement conforming to IS 12269.
(d) Rapid hardening Portland cements conforming to IS 8041.
(e) Portland stag cement conforming to IS 455.
(f) Portland Pozzolana cement (fly ash based) conforming to IS 1489 (Part 1).
(g) Portland Pozzolana cement (calcined clay based) conforming to IS 1489 (part 2).
(h) Hydophobic cement conforming to IS 8043.
(i) Low heat Portland cement conforming to IS 12600,
(j) Sulphates resisting Portland cement conforming to IS 12330.
(k) White cement conforming to IS 8042.

Different types of cement shall not be mixed together. In case more than one type of cement is used in any work, a record shall be kept showing the location and the types of cement used. Cement shall be tested before use as per IS : 4031 (Part-2, 3, 5, 6 and fixed).

2.1.2.3 Compressive Strength: Compressive strength requirement of each type of cement for various grades when tested in accordance with IS 4031 (part 6) shall be as under:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Gr-33</th>
<th>Gr.43</th>
<th>Gr.53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at testing.</td>
<td>Strength in N/mn² not less than for</td>
<td></td>
<td></td>
</tr>
<tr>
<td>72 + 1 hr</td>
<td>16</td>
<td>23</td>
<td>27</td>
</tr>
<tr>
<td>168+2hrs</td>
<td>22</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>672 + 4 hrs</td>
<td>33</td>
<td>43</td>
<td>53</td>
</tr>
</tbody>
</table>

2.1.2.4 Setting Time: Setting time of cement of any type of any grade when tested by Vicat apparatus method described in IS 4031 shall conform to the following requirement:
(a) Initial setting time: Not less than 30 minutes
(b) Final setting time; not more than 600 minutes

2.1.2.5 With Every delivery of cement producer’s certificate conforming that the supplied cement conforms to relevant specifications shall be accompanied. Cement must have identification marks on packages indicating date of manufacturing grade and type of cement batch no. etc. Cement brought to works shall not be more than 6 weeks old from the date of manufacture. Effective precautionary measures shall be taken to eliminate dust-nuisance during loading or transferring cement. Cement shall be accepted for work only after mandatory test.

2.1.2.6 Stacking and Storage: Cement in bags shall be stored and stacked in a shed which is dry, leak proof and as moisture-proof as possible. Cement bags shall be stacked at least 450 mm clear off the walls and in rows of two bags leaving in a space of at least 600 mm between two consecutive rows. In each row the cement bags shall be kept close together so as to reduce air circulation. Stacking shall not be more than 10 bags high to avoid lumping under pressure.

2.1.2.7 Different types of cement shall be stacked and stored separately. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received. For extra safety during monsoon, or when cement is expected to be stored for an unusually long period, each stack shall be completely enclosed by a water proofing membrane, such as polyethylene, which shall cover the top of the stack. Storage of cement at the work site shall be at the contractor’s expense and risk. Any damage occurring to cement due to faulty storage in contractor’s shed or on account of negligence on his part shall be the liability of the contractor.
2.1.3 Fine Aggregate
Aggregate most of which passes through 4.75 mm IS sieve is known as fine aggregate. Fine aggregate shall consist of natural sand, crushed stone sand, crushed gravel sand stone dust or marble dust, fly ash and broken brick (Burnt clay). The required mandatory tests for fine aggregate are given below:-

2.1.3.1 Organic impurities:
(a) Frequency of Testing:
(i) This shall be tested in field with minimum quantity of sand for carrying out of test 20cum. Every 20cum or part thereof or more frequently as decided by engineer in charge.

(ii) The test procedure.
The aggregate must also be checked for organic impurities such as decayed vegetation humus, coal dust etc. What is called the colour test is reliable indicator of the presence of harmful organic matter in aggregate, except in the area where there are deposits of lignite

Fill a 350 ml clear glass medicine bottle upto 70 ml mark with a 3% solution of caustic soda or sodium hydroxide. The sand is next added gradually until the volume measured by the sandy layer is 125 ml. The volume is then made upto 200 ml by addition of more of solution. The bottle is then stoppered and shaken vigorously and allowed to stand for 24 hours.-At the end of this period, the colour of the liquid will indicate whether the sand contains a dangerous amount of matter. A colourless liquid indicates a clean sand free from organic matter. A straw coloured solution indicates some organic matter but not enough to be seriously objectionable. Darker colour means that the sand contains injurious amounts and should not be used unless it is washed, and a retest shows that it is satisfactory.

Add 2.5 ml of 2% solution of tannic acid in 10% alcohol, to 97.5 ml of 3% sodium hydroxide solution. Place in a 350 ml bottle, fix the stopper, shake vigorously and allow standing for 24 hours before comparison with the solution above the sand.

Note: A 3% solution of caustic soda is made by dissolving 3 g of sodium hydroxide in 100 ml of water, preferably distilled. The solution should be kept in a glass of bottle tightly closed with a rubber stopper. Handling sodium hydroxide with moist hands may result in serious burns. Care should be taken not to spill the solution for it is highly injurious to clothing, leather, and other materials.

2.1.3.1.2 Silt Content:
(b) Frequency of Testing
(i) Silt content shall be tested in field. The quantity of sand for carrying out the test 20 cum. Every 20 cum or part thereof or more frequently as decided by Engineer-in-charge.

(ii) The test procedure.
The sand shall not contain more than 8% of silt as determined by field test with measuring cylinder. The method of determining silt contents by field test is given below:

A sample of sand to be tested shall be placed without drying in a 200 ml measuring cylinder. The volume of the sample shall be such that it fills the cylinder upto 100 ml mark. Clean water shall be added upto 150 ml mark. Dissolve a little salt in the water in the proportion one tea spoon to half a liter. The mixture shall be shaken vigorously, the last few shakes being sidewise direction to level off the sand and the contents allowed settling for three hours.

The height of the silt visible as settled layer above the sand shall be expressed as a percentage of the height of sand below. The sand containing more than the above allowable percentage of silt, shall be washed so as to bring the silt contents within allowable limits. Fine aggregate containing more than allowable percentage of silt shall be washed as many times as directed by Engineer-in-charge so as to bring the silt content within allowable limits for which nothing extra shall be paid.

2.1.3.1.3 Particle size distribution (sieve analysis):
(c) Frequency of Testing
(i) Particle size distribution shall be tested in field laboratory. Every 40 cum or part thereof or more frequently as decided by engineer in charge.

(ii) The test procedure
**Apparatus for test:** Perforated plate sieves of designation 10 mm, 4.75 mm and fine mesh sieve of designation 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron should be used. The balance or scale shall be such that it is readable and accurate to 0.1 per cent of the weight of the test sample.

**Sample for test:** The weight of sample available shall not be less than the weight given in the table below. The sample of sieving shall be prepared from the larger sample either by quartering or by means of a sample divider.

<table>
<thead>
<tr>
<th>Maximum size present in Substantial proportion (mm)</th>
<th>Minimum weight of sample for sieving (KG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00</td>
<td>0.5</td>
</tr>
<tr>
<td>4.75</td>
<td>0.2</td>
</tr>
<tr>
<td>2.36</td>
<td>0.1</td>
</tr>
</tbody>
</table>

**Test Procedure:** The sample shall be brought to an air-dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100 degree to 110 degree centigrade. The air dry sample shall be weighed and sieved successively on the appropriate sieves starting worth the largest. Care shall be taken to ensure that the sieves are clean before use.

Each sieve shall be shaken separately over a dean tray until not more than a trace passes, but in any case for a period of not less than two minutes. The shaking shall be done with a varied motion, backwards and forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions. Materials shall not be forced through the sieve by hand pressure, but on sieves coarser than 20 mm, placing of particles is permitted. Lumps of fine material, if present may be broken by gentle pressure with fingers against the side of the sieve. Light brushing of under side of the sieve with a soft brush may be used to clear the sieve openings.

Light brushing with a fine camel hair brush may be used on the 150 micron IS sieve to prevent segregation of powder and blinding of apertures. Stiff or worn out brushes shall not be used for this purpose and pressure shall not be applied to the surface of the sieve to force particles through the mesh. On completion of sieving the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

**Reporting of Results:** The results shall be calculated and reported as:
(a) The cumulative percentage by weight of the total sample passing each of the sieves, to the nearest whole number:
(b) The percentage by weight of the total sample passing one sieves & retained on the next smaller sieve, to the nearest 0.1 %.

**2.1.3.1.4 Bulking of sand:**
(d) Frequency of Testing:
(i) Bulking of sand shall be tested in field. The minimum quantity of sand for carrying out the test 20 cum. Every 20 cum or part thereof or more frequently as decided by the engineer in charge.

(ii) The test procedure
Two methods are suggested for determining the bulking of sand/fine aggregate. The procedure may be suitably varied, if necessary. Both depends on the fact that the volume of inundated sand/fine aggregate is the same if the sand/fine aggregate were dry.

Method -1: Put sufficient quantity of sand loosely into a container until it is about two-third full. Level off the top of the sand and push a steel rule vertically down through the sand at the middle to bottom, measure the height. Suppose this is ‘X’ cm. Empty the sand out of the container into another container where none of it is lost. Half fill the first container with water. Put back about half the sand and rod it with a steel rod, about 6 mm in diameter, so that its volume is reduced to a minimum. Then add the remainder and level the top surface of the inundated sand. Measure its depth at the middle with the steel rule. Suppose this is “Y” cm. The percentage of bulking of the sand due to moisture shall be
calculated from the formula.

Percentage bulking = \((X/Y - 1) \times 100\)

Method-2: In a 250 ml measuring cylinder, pour the damp sand, consolidate it by staking until it reached the 200 ml mark. Then fill the cylinder with the water and stir the sand well (the water shall be sufficient to submerge the sand completely). It will be seen that the sand surface is now below its original level. Suppose the surface is at the mark of Yml. The percentage of bulking of sand due to moisture shall be calculated from the formula.

Percentage bulking\(=\) \((200/Y - 1) \times 100\)

2.1.3.1.5 Grading : On the basis of particle size, fine aggregate is graded in to four zones. The grading when determined in accordance with the procedure para 2.1.3 shall be within the limits given in Table 2.2 below. Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron IS sieve, by a total amount not exceeding 5 per cent, it shall be regarded as falling within that grading zone.

<table>
<thead>
<tr>
<th>IS Sieve</th>
<th>Percentage passing for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading Zone I</td>
</tr>
<tr>
<td>10 mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
</tr>
<tr>
<td>600 microns</td>
<td>15-34</td>
</tr>
<tr>
<td>300 microns</td>
<td>5-20</td>
</tr>
<tr>
<td>150 microns</td>
<td>0-10</td>
</tr>
</tbody>
</table>

Note 1: For crushed stone sands, the permissible limit on 150 micron sieve is increased to 20 per cent. This does not affect the 5 per cent allowance permitted in 3.1.3.4 (e) (1) applying to other sieves.

Note 2: Allowance of 5% permitted in 3.1.3.4 (e) (1) can be split up, for example it could be 1% on each of three sieves and 2% on another or 4% on one sieve and 1% on another.

Note 3: Fine aggregate conforming to Grading Zone IV shall not be used in reinforced cement concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

Note 4: Sand requiring use for mortar for plaster work shall conform to IS 1542 and for masonry work shall conform to IS 2116.

2.1.3.2. Type of Fine Aggregate to be Used :- Type and grading of fine aggregate to be used shall be specified. It shall be coarse sand, fine sand, stone dust or marble dust fly ash and surkhi.

(a) Coarse sand shall be either river sand or pit sand or a combination of the two. It shall be clean, sharp, angular, gritty to touch and composed of hard siliceous material. Its grading shall fall within the limits of grading zone 1, II, III of Table 2.2. Grading of sand shall conform to IS 2116 for use in Masonry work.

(b) Fine sand shall be either river sand or pit sand or a combination of the two. Its grading shall fall within the limits of Grading zone IV of Table 2.2. Grading of sand shall conform to IS 1542 for use in plaster work.
(c) Stone dust shall be obtained by crushing hard stones or gravel. Its grading shall fall within the limits of grading Zone, I, II, or III of Table 3.1.

(d) Marble dust shall be obtained by crushing marble. Its grading shall fall within the limits of Grading Zone IV of Table 3.1. Grading of Marble dust for use in Mortar shall be as per following table 2.3.

Table No. 2.3  
Grading of Marble Dust

<table>
<thead>
<tr>
<th>IS Sieve</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>95-100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>600 micron</td>
<td>80-100</td>
</tr>
<tr>
<td>300 micron</td>
<td>15-50</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-15</td>
</tr>
</tbody>
</table>

(e) Sand for Masonry Mortar and for Plaster - Sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. Sand shall be hard durable, clean and "free from adherent coating and organic matter and shall not contain the amount of clay, silt and fine dust more than specified as under.

2.1.3.2 Deleterious Material: Sand shall not contain any harmful impurities such as iron, pyrites, alkalis, salts, coat or ether organic impurities, mica, shale or similar laminated materials, soft fragments, sea shale in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar. The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand / Marble dust shall not exceed the following limits:

1 Clay, fine silt and fine dust when determined in accordance within IS 2386 (Part II). In natural sand or crushed : gravel sand & crushed stone sand Not more than 5% by mass

2 Organic impurities when determined in accordance with IS 2386 (Part II) Colour of the liquid shall be lighter than that indicated by the standard specified in IS 2386 (Part II).

Grading of sand for use in masonry mortar shall be conforming to IS 216 & for Plaster conforming to IS 1542 (Table 2.4 below):

Table No. 2.4  
Grading of Sand for use in Mortar and Plaster

<table>
<thead>
<tr>
<th>IS Sieve designation</th>
<th>For use in masonry mortar</th>
<th>For internal and external wall and ceiling plaster</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>percentage passing by</td>
<td>percentage passing by mass</td>
</tr>
<tr>
<td>10 mm</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>100</td>
<td>95-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>90-100</td>
<td>95-100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>70-100</td>
<td>90-100</td>
</tr>
<tr>
<td>600 microns</td>
<td>40-100</td>
<td>80-100</td>
</tr>
<tr>
<td>300 microns</td>
<td>5-70</td>
<td>20-65</td>
</tr>
<tr>
<td>150 microns</td>
<td>0-10</td>
<td>0-15</td>
</tr>
</tbody>
</table>
2.1.3.3 **Bulking:** Fine aggregate, when dry or saturated, has almost the same volume but dampness causes an increase in volume. In case fine aggregate is damp at the time of proportioning the ingredients for mortar or concrete, its quantity shall be increased suitably to allow for bulking, which shall be determined by the method described in para 2.1.3.1.4 Table 2.5 gives the relation between moisture content and percentage of bulking for guidance only.

<table>
<thead>
<tr>
<th>Moisture content %</th>
<th>Bulking % age (by)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
</tbody>
</table>

2.1.3.4 **Stacking:** Fine aggregate shall be so stacked as to prevent dust and foreign matter getting mixed up with it as far as practically possible. Marble dust in dry condition shall be collected in bags and properly staked so as not to form lumps; suitable arrangements shall be made to protect it from moisture similar to those adopted for stacking of cement bags.

2.1.3.5 **Measurements:** As the fine aggregate bulks to a substantial extent when partially wet, measurements shall be taken when the stacks are dry or appropriate allowance made for bulking.

2.1.4 **Broken Brick (Burnt Clay) Fine Aggregate**

Broken Brick (Burnt Clay) Fine Aggregate, also known as Surkhi, shall be made by grinding well burnt (but not under or over burnt) broken bricks as specified in IS 3068-1986. It shall not contain any harmful impurities, such as iron pyrites, salts, coal, mica, shale or similar laminated or other materials in such form of quantity as to adversely affect hardening, strength, durability or appearance of the mortar. The maximum quantities of clay, fine silt, fine dust and organic impurities in surkhi (all taken together) shall not exceed 5% by weight. The particle size grading of surkhi for use in lime mortars shall be within the limits specified in Table 2.6.

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing (by wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 mm</td>
<td>100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>70-100</td>
</tr>
<tr>
<td>600 microns</td>
<td>40-100</td>
</tr>
<tr>
<td>300 microns</td>
<td>5-70</td>
</tr>
<tr>
<td>150 microns</td>
<td>0-15</td>
</tr>
</tbody>
</table>

2.1.4.1 **Stacking:** Surkhi shall be stacked on a hard surface or platform so as to prevent the admixture of clay, dust, vegetation and other foreign matter; it shall be also protected from rain and dampness and kept under adequate coverings.

2.1.4.2 **Measurements:** Surkhi shall be measured in regular stacks in cubic meters. Alternatively it may be measured by weight when supplied in bags.

2.1.5 **Fly Ash**

Fly ash is the pulverized fuel ash extracted from the flue gases by any suitable process such as cyclone separation or electrostatic precipitation. The ash collected from the bottom of boilers is termed as bottom ash. Fly ash is finer than bottom ash. Siliceous fly ash (ASTM Class F) containing calcium oxide less than 10% by mass is normally produced from burning anthracite’ or bituminous coal and possesses Pozzolanic properties. Calcareous fly ash (ASTM Class C) is produced by burning lignite or sub-bituminous coal and contains calcium oxide more than 10% by mass; the content could be as high as 25%. This fly ash has both hydraulic and Pozzolanic properties. It shall be clan and free from any contamination of bottom ash, grit or small pieces of pebbles. It is obligatory on the part of supplier/ manufacture that the fly ash conforms to the requirements if mutually agreed upon & shall furnish a certificate to this effect to the purchaser or his representative. Mandatory test required shall be as
below:-

(i) Total chloride in percent by mass max: - It is tested as per IS 12423 in laboratory. The minimum quantity of sample for each above testing is 10 cubic meter the frequency of testing for every 10cum or part thereof or more.

(ii) Loss of ignition in percent by mass max :- It is tested as per procedure as given in IS 1727 in laboratory the minimum quantity of sample for each above testing is 10 cum. Frequency as decide by the engineer in charge.

(iii) Specific surface in m²/ kg: - It is tested as per Blaine’s permeability. The minimum quantity of sample for each above testing is 10cum. Frequency as decide by the engineer in charge.

(iv) Compressive strength at 28 days in N/mm² minimum: - it is tested in laboratory .The minimum quantity of sample for each above testing is 10cum. Only in cases when fly ash is used as pozzolana in cement.

2.1.5.1 Characteristics: The chemical properties of fly ash shall be as per IS 3812 (part 1 & 2) depending on the usage. The physical requirements of fly-ash shall be as specified as below.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Characteristics</th>
<th>Requirement of Fly Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>For use as Pozzolana</td>
</tr>
<tr>
<td>(i)</td>
<td>Fineness- Specific surface in m²/kg by Blaine's permeability method, min</td>
<td>320</td>
</tr>
<tr>
<td>(ii)</td>
<td>Lime reactivity average compressive strength in N/mm² Min</td>
<td>4.5</td>
</tr>
<tr>
<td>(iii)</td>
<td>Compressive strength at 28 days in N/ mm²</td>
<td>Not less than 80 % of the strength of corresponding mortar cubes.</td>
</tr>
<tr>
<td>(iv)</td>
<td>Soundness of autoclave test expansion of specimens, per cent, max</td>
<td>0.8</td>
</tr>
<tr>
<td>(V)</td>
<td>Particles retained on 45 micron IS sieve (wet sieving) in percent maximum</td>
<td>34</td>
</tr>
</tbody>
</table>

2.1.5.2 Stacking: Fly ash shall be protected from dirt collecting on it.

2.1.5.3 Measurements: Fly ash shall be measured in regular stacks in cubic meters. Alternatively it may be measured by weight when supplied in bags.

2.2 PREPARATION OF MORTARS AND ITS GRADE

2.2.1 Grade of Masonry Mortar

The grade of masonry mortar will be defined by its compressive strength in N/mm² at the age of 28 days as determined by the standard procedure detailed in IS 2250. For proportioning the ingredients by volume, the conversion of weight into volume shall be made on the following basis:

| (a) Burnt Clay Pozzolana | 860 Kg/cum |
| (b) Coarse Sand (dry) | 1280 kg/cum |
| (c) Fine sand (dry) | 1600 kg/cum |
| (d) Fly Ash | 590 Kg/ cum |
2.2.1.1 Grades and criteria for selection of Masonry mortars are as below:

Masonry mortars shall preferably be specified by the grade in terms of their minimum compressive strength as given in Table No. 2.9.

Table No.- 2.9

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Grade</th>
<th>Compressive strength at 28 days in MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MM 0.7</td>
<td>0.7 to 1.5</td>
</tr>
<tr>
<td>2</td>
<td>MM 1.5</td>
<td>1.5 to 2.0</td>
</tr>
<tr>
<td>3</td>
<td>MM 2</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>4</td>
<td>MM 3</td>
<td>3.0 to 5.0</td>
</tr>
<tr>
<td>5</td>
<td>MM 5</td>
<td>5.0 to 7.5</td>
</tr>
<tr>
<td>6</td>
<td>MM 7.5</td>
<td>7.5 &amp; above</td>
</tr>
</tbody>
</table>

(a) The selection of masonry mortars from durability consideration will have to cover both the loading and exposure condition of the masonry. The masonry mortar shall generally be as specified below.

(b) In case of masonry exposed frequent to rain and where there is further protection by way of plastering or rendering or other finishes, the grade of mortar shall not be less than 0.7 MM but shall preferably be of grade MM2. Where no. protection is provided, the grade of mortar for, external wall shall not be less than MM2.

(c) In case of load bearing internal walls, the grade of mortar shall preferably be MM 0.7 or more for high durability but in no case less than MM 0.5.

(d) In the case of masonry work in foundations laid below damp proof course, the grade of mortar for use in masonry shall be as specified below.

   (i) Where soil has little moisture, masonry mortar of grade not less than MM 0.7 shall be used.

   (ii) Where soil is very damp, masonry mortar of grade preferably MM 2 or more shall be used. But in no case shall the grade of mortar be less than MM 2.

(e) For masonry in building subject to vibration of machinery, the grade of mortar shall not be less than MM 3.

(f) For parapets, where the height is greater than thrice the thickness, the grade of masonry mortar shall not be less than MM3. In case of low parapets the grade of mortar shall be the same as used in the wall masonry.

(g) The grade of mortar for bedding joints in masonry with large concrete blocks shall not be less than MM 3.

(h) The compressive strength shall be determined in accordance with the procedure given in IS 2250.

(i) While mixing the Pozzolanic material likes fly ash in mortars Ordinary Portland cement only shall be used.

Note: Compressive strength shall be determined in accordance with the Appendix -A-IS 2550.

2.2.2 Cement Mortar

This shall be prepared by mixing cement and sand with or without the addition of pozzolana in specified proportions requirement of the strength (IS Code 2250).

2.2.2.1 Proportioning: Proportioning on weight basis shall be preferred taking into account specific gravity of sand and moisture content. Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic meter. Other ingredients in
specified proportion shall be measured using boxes of size 40 x 35 x 25 cm. Sand shall be measured on the basis of its dry volume in the case of volumetric proportioning.

2.2.2.2 Mixing
The mixing of mortar shall be done in mechanical mixers operated manually or by power as decided by Engineer-in-Charge. The Engineer-in-Charge may, however, permit hand mixing at his discretion taking into account the nature, magnitude and location of the work and practicality of the use of mechanical mixers or where item involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In cases, where mechanical mixers are not to be used. The contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

(a) Mechanical Mixing: Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least three minutes, only the required quantity of water shall be added which will produce mortar of workable consistency but not stiff paste. Only the quantity of mortar, which can be used within 30 minutes of its mixing, shall be prepared at a time. Mixer shall be cleaned with water each time before suspending the work.

(b) Hand Mixing: The measured quantity of sand shall be leveled on a clean masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a masonry trough with just sufficient quantity of water to bring the mortar to a stiff paste of necessary working consistency.

2.2.3 Precautions: mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

2.2.3 Cement Fly ash Sand Mortar
This shall be prepared by mixing cement, fly ash and sand in specified proportions. Mixing shall be done in a mechanical mixer (operated manually or by power) unless otherwise permitted by the Engineer-in-Charge in writing. The Engineer-in-Charge may, however, permit hand mixing at his discretion, taking into account the nature, magnitude and location of the work and practicality of the use of mechanical mixer or where items involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In case, where mechanical mixer is not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

2.2.3.1 Proportioning: Proportioning on weight basis shall be preferred taking into account specific gravity of Fly Ash, sand and moisture content. Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic meter. Other ingredients in the specified proportions shall be measured using boxes of suitable sizes. Sand and fly ash shall be measured on the basis of their dry volume in the case of volumetric proportioning.

2.2.3.2 Mixing
(a) Mechanical Mixing: Sand and flash in the specified proportions shall be mixed dry in a mixer and then the specified quantity of cement shall be added and mixed dry thoroughly. Water shall then be added gradually and wet mixing continued for at least one minute. Water shall be just sufficient to bring the mortar to the consistency of a workable paste. Only the quantity of mortar which can be used within 30 minutes of its mixing shall be prepared at a time.

(b) Hand Mixing: The measured quantity of sand and flash shall be mixed dry on a clean masonry platform before adding specified quantity of cement to it. The resulting mixture of cement, sand and fly ash shall then be mixed thoroughly being turned over forward and backward several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a clean watertight masonry trough with just sufficient quantity of water, to bring the mortar to a stiff paste of necessary working consistency.

2.2.3.3 Precautions: Shall be the same as specified in 2.2.3.3.
## List of Bureau of Indian Standard Codes

<table>
<thead>
<tr>
<th>No.</th>
<th>IS Code</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
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<td>IS 259</td>
<td>Specification for S3 grade ordinary Portland cement</td>
</tr>
<tr>
<td>2</td>
<td>IS 383</td>
<td>Specification for coarse and fine aggregate from natural Source for concrete.</td>
</tr>
<tr>
<td>3</td>
<td>IS 455</td>
<td>Specification for Portland slag cement.</td>
</tr>
<tr>
<td>4</td>
<td>IS 460 (Part I)</td>
<td>Specification for test sieves: wire cloth test sieves.</td>
</tr>
<tr>
<td>5</td>
<td>IS 650</td>
<td>Specification for standard sand for testing of cement</td>
</tr>
<tr>
<td>6</td>
<td>IS 1269</td>
<td>Specification for 53 grade ordinary Portland cement</td>
</tr>
<tr>
<td>7</td>
<td>IS 1344</td>
<td>Specification for calcined clay Pozzolana.</td>
</tr>
<tr>
<td>8</td>
<td>IS 1489</td>
<td>Specification for Portland pozzolana cement</td>
</tr>
<tr>
<td>9</td>
<td>IS 1542</td>
<td>Specification for sand for plaster</td>
</tr>
<tr>
<td>10</td>
<td>IS 1727</td>
<td>Methods of Test for Pozzolanic materials</td>
</tr>
<tr>
<td>11</td>
<td>IS 2116</td>
<td>Specification for sand for masonry mortar.</td>
</tr>
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3:0 CONCRETE WORK
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Definitions

Accelerator – A substance which when added to concrete, mortar or grout, increases the rate of hydration of cement, shortens the time of setting, or increases the rate of hardening or strength development.

Aggregate: - Granular material, generally, inert, such as , manufactured sand, gravel, crushed gravel, crushed stone and air cool iron blast furnace slag which when bound together into a conglomerated mass by a matrix forms concrete or mortar.

Batch: - Quantity of concrete or mortar mixed at one time.

Batching: - Weighing or volumetrically measuring and introducing into the mixture the ingredients for a batch of concrete or mortar.

Blinding:- the application of layer of weak concrete or other suitable material to reduce surface voids, or to provide a clean dry working surface, also the filling or plugging of the openings in a screen or sieve by the material being separated.

Bulking of sand: - Increase in bulk volume of a quantity of sand in a moist condition over the volume of the same quantity, dry or completely inundated.

Centering: - Specialized form work used in the construction of arches, shells, and space structures, or any continues structure where the entire false work is lowered (struck or decentered) as a unit to avoid the introduction of injurious stress in any part of the structure.

Consistency: - The relative mobility or ability of freshly mixed concrete or mortar to flow, the usual measurement are slump for concrete and flow for mortar cement paste or grout.

Curing: - Maintenance of humidity and temperature of freshly placed concrete during some defined period following placing, casting or finishing assuring satisfactory hydration of the cementitous materials and proper hardening of the concrete.

Durability: - The ability of concrete to resist weathering action chemical attack abrasion and other condition of service.

Expansion joint- A separation between adjoining part of a concrete structure which is provided to allow small relative movements such as those caused by thermal changes to allow small relative movements such as those caused by thermal changes to occur independently.

Flakiness index: - The flakiness index of an aggregate is the percentage by weight of particles in it whose least dimensions (thickness) is less than three fifth of their mean dimension.

Form work- Complete system of temporary structure built to contain fresh concert so as to form it to the required shape and dimensions and to support it until it hardens sufficiently to become self supporting, form work includes the surface in contact with the concrete and all necessary supporting structure.

Grout- Mixture of cementitous material and aggregate to which sufficient water is added to produce pouring consistency without segregation of the constituents, or mixtures of other compositions, such as containing PVC or epoxy resin or sodium silicate, but of similar consistency.

Laitance- A layer of weak and nondurable material containing cement and fines form aggregates, brought by bleeding water to the top of over wet concrete, the amount of which is generally increased by overworking or over manipulating concrete at the surface by improper finishing or by job traffic.

Peeling- A process in which thin flaxes of mortar are broken away form concrete surface, such as by deterioration or by adherence of surface mortar to forms as forms are removed.

Plumb- A large random-shaped stone dropped into freshly placed mass concrete.
Prestressed concrete- Concrete in which internal stress of such magnitude and distribution are introduced that the tensile stresses resulting from service loads are counteracted to a desired degree, in reinforced concrete the priestess is commonly introduced by tensioning the tendons.

Proportioning- Selection of proportioning of ingredients for mortar or concrete to make the most economical use of available material to produce mortar or concrete of the required properties.

Retarder- An admixture which delays the setting of the cement paste and hence of mixtures, such as mortar or concrete containing cement.

Retempering- Addition of water and remixing of concrete or mortar which has started to stiffen.

Segregation- The differential concentration of the components of mixed concrete, aggregate, or the like, is resulting in no uniform proportion in the mass.

Slump- A measure of consistency of freshly mixed concrete, mortar or stucco equal to the subsidence measured to the nearest 6 mm of the moulded truncated cone immediately after removal of the slump cone.

Slurry- A mixture of water and any finely divided insoluble materials, such as Portland cement, slag or soil, in suspension.

Specific gravity- The ratio of the mass of a unit volume of a material at a stated temperature to the mass of the same volume of a gas free distilled water at a stated temperature.

Sub grade- The soil prepared and compacted to support a structure or a pavement system.

Tamping: - The operation of compacting freshly placed concrete by repeated blows.

Texture: - The par ten of configuration apparent in an exposed surface, as of concrete or mortar, including roughness, sticking, striation, or departure from flatness.

Tolerance- The permitted variation from a given dimension or quantity.

Tremie- A pipe or tube through which concrete is deposited under water, having at its upper end a hopper for filling and bail by means of which the assembly can be handled by derrick.

Vibrator- An oscillating machine used to agitate fresh concrete so as to eliminate gross voids, including entrapped air but not entrained air, and produces intimate contact, with form surfaces, and embedded materials.

Water cement ratio- The ratio of the amount of water, exclusive of that absorbed by the aggregates, though amount of cement in a concrete or mortar mixture, preferably stated as a decimal by weight.

Wearing course- A topping or surface treatment to increase the resistance of a concrete pavement or slab to abrasion.

Workability- That property of freshly mixed concrete or mortar which determines the case and homogeneity with which it can be mixed, placed, compacted and finished. It is the amount of energy to overcome friction and calls full consolidation.

3.1. Concrete Material
The following materials are the component of concrete: - Water, cement, fine aggregate or sand, surkhi, and fly ash.

3.1.1 Coarse Aggregate
Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Types of core aggregates are as below:
(a) **Stone Aggregate:** It shall conform to IS 383 unless otherwise specified. It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean and free from veins, adherent coating, and injurious amounts of disintegrated pieces, alkali, vegetable matter and other harmful substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided.

(b) **Gravel:** These shall conform to IS 383 unless otherwise specified. It shall consist of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean; it shall be free from flat particles of shale or similar laminated material, powdered clay, silt, loam, adherent coating, alkali, vegetable matter and other harmful substances. Pit gravel shall be washed if it contains soil materials adhering to it.

(c) **Brick Aggregate:** It shall conform to IS 306 unless otherwise specified and shall be obtained by breaking well burnt or over burnt dense brick/ brick bats. They shall be homogeneous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil, vegetable matter and other harmful substances. Such aggregate should not contain more than 1% of Sulphates and should not absorb more than 10% of their own mass of water, when used in cement concrete.

(d) Light weight aggregate such as sintered fly ash aggregate may also be used provided the Engineer-in-Charge is satisfied with the data on the proportion of concrete made with them.

3.1.1.1 **Deleterious Material:** Course aggregate shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to attack the steel reinforcement. Aggregates which are chemically reactive with alkalies of cement shall not be used. The maximum quantity of harmful material shall not be more than 5% of the weight of coarse aggregate when determined in accordance with IS 2386.

3.1.1.2 **Size and Grading of coarse aggregate:**

(i) **Stone aggregate and gravel:** It shall be either graded or single sized as specified. Nominal size and grading shall be as under:

(a) Nominal sizes of graded stone aggregate or gravel Shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes as determined by the method shall be in accordance with Table 3.2.

**DETERMINATION OF PARTICLE SIZE**

The apparatus, sample size and test procedure shall be same as specified in sub-head 'MORTARS'. In order that the sieves shall not be overloaded, care must be taken to ensure that the maximum sieve loads shown in Table below are not exceeded at the completion of sieving.

<table>
<thead>
<tr>
<th>I.S. Sieve Designation</th>
<th>Maximum weight for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45 cm dia sieve kg</td>
</tr>
<tr>
<td>45 mm</td>
<td>10</td>
</tr>
<tr>
<td>40 mm</td>
<td>8</td>
</tr>
<tr>
<td>31.5 mm or 22.1 mm</td>
<td>6</td>
</tr>
<tr>
<td>20 mm</td>
<td>4</td>
</tr>
<tr>
<td>16 mm or 12.5 mm</td>
<td>3</td>
</tr>
<tr>
<td>10 mm</td>
<td>2</td>
</tr>
<tr>
<td>5.6 mm</td>
<td>1.5</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>1.0</td>
</tr>
<tr>
<td>3.35 mm</td>
<td>-</td>
</tr>
</tbody>
</table>

The sample weight taken will thus normally require several operations on each sieve. Each sieve should be taken separately over a clean tray or receiver until no more than a trace passes, but in any case for not less than two minutes. Materials should not be forced through the apertures but hand placing is permitted. A light brush should be used with fine sieves. The cumulative weight passing each sieve should be calculated as percentage of the total sample weight to the nearest whole number.
TABLE 3.2 Graded Stone Aggregate or Gravel

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing (by weight) for nominal size of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 mm</td>
</tr>
<tr>
<td>80 mm</td>
<td>100</td>
</tr>
<tr>
<td>63 mm</td>
<td>-</td>
</tr>
<tr>
<td>40 mm</td>
<td>95 to 100</td>
</tr>
<tr>
<td>20 mm</td>
<td>30 to 70</td>
</tr>
<tr>
<td>16 mm</td>
<td>-</td>
</tr>
<tr>
<td>12.5mm</td>
<td>-</td>
</tr>
<tr>
<td>10 mm</td>
<td>10 to 35</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>O to 5</td>
</tr>
</tbody>
</table>

(b) Nominal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal sizes, the proportion of other sizes as determined by the method prescribed in para 3.1.1.2 determination of particle size shall be in accordance with Table 3.3.

TABLE 3.3 Single Sized (Ungraded) Stone Aggregate or Gravel

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing (by weight) for nominal size of 63 mm</th>
<th>40 mm</th>
<th>20 mm</th>
<th>16 mm</th>
<th>12.5mm</th>
<th>10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 mm</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>63 mm</td>
<td>85-100</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40 mm</td>
<td>0-30</td>
<td>85-100</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20 mm</td>
<td>0-5</td>
<td>0-20</td>
<td>85-100</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>16 mm</td>
<td>-</td>
<td>-</td>
<td>85-100</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12.5mm</td>
<td>-</td>
<td>-</td>
<td>85-100</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10mm</td>
<td>0-5</td>
<td>0-5</td>
<td>0-20</td>
<td>0-30</td>
<td>0-45</td>
<td>85-100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>-</td>
<td>-</td>
<td>0-5</td>
<td>0-5</td>
<td>0-10</td>
<td>0-20</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0-5</td>
</tr>
</tbody>
</table>

(c) When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sized aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal size, the proportion of other sizes in mixed aggregate as determined by method prescribed in para 3.1.1.2 determination of particle size shall be in accordance with Table 3.4. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 3.4.

TABLE 3.4 Single Sized (Ungraded) Stone Aggregate or Gravel

<table>
<thead>
<tr>
<th>Cement concrete</th>
<th>Nominal size of graded aggregate required</th>
<th>Parts of single size aggregate of size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50mm</td>
<td>40mm</td>
</tr>
<tr>
<td>1:6:12</td>
<td>63</td>
<td>9</td>
</tr>
<tr>
<td>1:6:12</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>1:5:10</td>
<td>63</td>
<td>7.5</td>
</tr>
<tr>
<td>1:5:10</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>1:4:8</td>
<td>63</td>
<td>6</td>
</tr>
<tr>
<td>1:4:8</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>1:3:6</td>
<td>63</td>
<td>4.5</td>
</tr>
<tr>
<td>1:3:6</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>1:3:6</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>1:3:6</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>1:2:4</td>
<td>40</td>
<td>-</td>
</tr>
<tr>
<td>1:2:4</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>1:2:4</td>
<td>12.5</td>
<td>-</td>
</tr>
<tr>
<td>1:1½:3</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Note:

(i) The proportions indicated in Table 3.4 above are by volume when considered necessary, these proportions may be varied marginally by Engineer-in-Charge after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the Engineer-in-Charge. If single size coarse aggregate are not premixed at site to obtain the graded coarse aggregate required for the mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.

(ii) **Brick Aggregate**: Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in Table 3.5 when tested for sieve analysis for the method prescribed in para 3.1.1.2 determination of particle size.

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 mm</td>
<td>100</td>
</tr>
<tr>
<td>37.5 mm</td>
<td>95 -100</td>
</tr>
<tr>
<td>20.0 mm</td>
<td>45 -100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>0.50</td>
</tr>
</tbody>
</table>

3.1.1.3 **Stacking**: Aggregate shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

3.1.1.4 **Testing**: Coarse aggregate shall be tested for the followings (as per IS 2386) required Test, Test Procedure, Sample Quantity & Frequency of Testing are given below:

(i) Test for percentage of soft of deleterious: It shall be tested in field are in laboratory., (a) Test Procedure :- As per IS 2386 Part-II., (b) Minimum Quantity of Material for Carrying out test : As required by the Engineer-in-Charge., (c) Frequency of Testing :- For all Quantity.

(ii) Test for particle size: It shall be tested in field or in laboratory., (a) Test Procedure :- As per para 3.1.1.2 of this chapter, (b) Minimum Quantity of Material for Carrying out test : 45 cum, (c) Frequency of Testing :- For every 45 cum meter or part thereof for RCC Work only. For rest of items as decided by Engineer-in-charge.

(iii) Test for estimation of organic impurities: It shall be tested in field or in laboratory., (a) Test Procedure :- As per IS 2386 part-II, (b) Minimum Quantity of Material for Carrying out test : 10 cum, (c) Frequency of Testing :- For every 40 cum meter or part thereof.

(iv) Test for Surface moisture: It shall be tested in field or in laboratory., (a) Test Procedure :- As per IS 2386, (b) Minimum Quantity of Material for Carrying out test : 10 cum, (c) Frequency of Testing :- For every 40 cum meter or part thereof.

(v) Test for Determination of 10% fire value: It shall be tested in field or in laboratory., (a) Test Procedure :- As per IS 2386, (b) Minimum Quantity of Material for Carrying out test : 10 cum, (c) Frequency of Testing :- For every 40 cum meter or part thereof.

(vi) Test for Specific gravity: It shall be tested in field or in laboratory., (a) Test Procedure :- As per IS 2386, (b) Minimum Quantity of Material for Carrying out test : 10 cum, (c) Frequency of Testing :- For every 40 cum meter or part thereof.

(vii) Test for Bulk density: It shall be tested in field or in laboratory., (a) Test Procedure :- As per IS 2386, (b) Minimum Quantity of Material for Carrying out test : 10 cum, (c) Frequency of Testing :- For every 40 cum meter or part thereof.

(viii) Test for Aggregate crushing strength: It shall be tested in field or in laboratory., (a) Test Procedure :- As per IS 2386 Part-IV, (b) Minimum Quantity of Material for Carrying out test : 10 cum, (c) Frequency of Testing :- For every 40 cum meter or part thereof.
(ix) Test for Aggregate impact value: It shall be tested in field or in laboratory. (a) Test Procedure: -
As per IS 2386 Part-IV, (b) Minimum Quantity of Material for Carrying out test: 10 cum, (c)
Frequency of Testing: - For every 40 cum meter or part thereof.

(x) Test for Concrete: The slump test and compressive strength test (Cube Test) shall be done. The procedure of testing, Frequency of Testing & Quantity of material for carrying out test are given below.

(1) Slump Test: - This test shall be conducted at field, (a) Test Procedure: As given in clause
3.2.2.1 (c) Minimum Quantity of Material for Carrying out test: 10 cum, (c) Frequency of Testing :
15 cum or part thereof.

(2) Compressive strength test (Cube Test): This test shall be done at lab, (a) Test Procedure : -
As given in clause 3.2.2.4, (c) Minimum Quantity of Material for Carrying out test: (i) 5 cum in case of column, (ii) 20 cum for slabs, beams and connected columns, (iii) 20 cum for other R.C.C. work for all other small items and where R.C.C. done in a day is less than 5 cum test may be carried out as required by Engineer-in-Charge, (c) Frequency of Testing : (i) Every 5 cum or part thereof, (ii) Every 20 cum or part thereof, (iii) Every 20 cum or part thereof.

(a) Determination of particle size and shape para 3.1.1.2 of this chapter.

(b) Estimation of organic impurities (as per IS 2386 - Part II)

c) Test for surface moisture.

Take a sample of wet aggregate and weigh it (A). Then place it in a frying pan and gently apply heat, meanwhile stirring with a glass rod until the surface moisture disappears. This is apparent when the aggregate loses its shining wet appearance and becomes dull, or when it just attains a free running condition. The saturated surface dry material is then weighed (B). Continue the heating thereafter until the moisture is evaporated and weigh the dry sample (C). The surface moisture is then calculated as follows:

Surface moisture = 100 x \[ A - B \]
\[ C \]

It is expressed as a percentage of dry aggregate.

(d) Determination of 10% fine value

Apparatus: The apparatus for the standard test shall consist of the following:
(i) A 15 cm diameter open-ended steel cylinder, with plunger and base-plate, as shown in Fig. below. The surfaces in contact with the aggregate shall be machined and case hardened or otherwise treated so as to have a diamond (VH) pyramid hardness number of not less than 650 VH.

(ii) A straight metal tamping rod of circular cross-section 16 mm in diameter and 45 to 60 cm long, rounded at one end.

(iii) A balance of capacity 3 Kg, readable and accurate to one gram.

(iv) I.S. Sieve of sizes 12.5, 10 and 2.36 mm.

(v) A compression testing machine capable of applying a load of 50 tones and which can be operated to give a uniform rate of loading so that the maximum load in any test is reached in 10 minutes. This load may vary from 0.5 to 50 tones.

(vi) For measuring the sample, a cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions:

Diameter 11.5 cm

Height 18.0 cm
(vii) Means of measuring the reduction in the distance between the plates of the testing machine to the nearest one millimeter during the test (for example, dial gauge).

Test Sample: Material for the test shall consist of aggregate passing a 12.5 mm I.S. Sieve and retained on a 10 mm I.S. Sieve. The aggregate shall be tested in a surface dry condition. If dries by heating the period of drying shall not exceed four hours, the temperature shall be 100°C to 110°C and the aggregate shall be cooled to room temperature before testing.

The quantity of aggregate shall be such that the depth of material in the cylinder, after tamping as described below, shall be 10 cm.

The weight of material comprising the test sample shall be determined (weight A) and the same weight of sample be taken for the repeat test.

Note: About 6.5 kg of natural aggregate is required to provide the two test samples. Less of light weight aggregate is required.

The measuring cylinder is filled in three layers of approximately equal depth with aggregate passing a 12.5 mm I.S. Sieve and retained on 10 mm I.S. Sieve. Each layer is subjected to 25 strokes from the tamping rod (16 mm dia and 45 to 60 cm long) rounded to one end, care being taken in case of weak materials not to break the particles. The surface of the aggregate shall be carefully leveled and the plunger inserted so that it rests horizontally on this surface.

Test Procedure: The apparatus, with the test sample and plunger in position, shall then be placed in the compression testing machine. The load shall be applied at a uniform rate so as to cause a total penetration of a plunger in 10 minutes of about 15.0 mm for rounded or partially rounded aggregates (for example uncrushed gravel) 20 mm for nominal crushed aggregate & 24 mm for honey combed aggregate (for example expanded shale’s and slag’s). These figures may be varied according to the extent of the rounding or honey combing.

After reaching the required maximum penetration, the load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm I.S. Sieve. The fines passing the sieve shall be weighed, and this weight expressed as a percentage of the weight of the test sample. Normally, this percentage will fall within the range 7.5 to 12.5, but if it does not, a further test shall be made at a load adjusted appropriately, to bring the percentage fines within the range of 7.5 to 12.5.

A repeat test shall be made at the load that gives as percentage fines within the range 7.5 to 12.5.

Calculations: The mean percentage fines from the two tests at this load shall be used in the following formula to calculate the load required to give 10% fines.

\[
\text{Load required for 10\% fines} = \frac{14X}{Y+4}
\]

Where

- \(X\) = Load in tonne and
- \(Y\) = mean percentage fines from two test at X tonne load.

Reporting of Results: The load required to produce 10% fines shall be reported to the nearest, whole number for loads of 10 tonnes or more, the nearest 0.5 tonne for loads of less than 10 tonnes. The value expressed to the nearest 0.5 tonne should be as follows:

(a) For normal concrete, not less than 5 tonnes.
(b) For wearing surfaces, not less than 10 tonne.
(c) For granolithic concrete, not less than 15 tonnes.
3.1.1.5 **Measurements:** The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregate of nominal size below 40 mm.

3.1.2 **Chemical Admixtures**

When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS 9103.

Admixtures should not impair durability of concrete nor combine with the constituent to form harmful compounds nor increase the risk of corrosion of reinforcement.

The workability, compressive strength and the slump loss of concrete with and without the use of admixtures shall be established during the trial mixes before use of admixtures.

The relative density of liquid admixtures shall be checked for each drum containing admixtures and compared with the specified value before acceptance.

The chloride content of admixtures shall be independently tested for each batch before acceptance.

It two or more admixtures are used simultaneously in the same concrete mix, data should be obtained to assess their interaction and to ensure their compatibility.

3.1.2.1 Admixtures may be any one of the following classes for use in concrete:-
(a) Water Reducing Admixtures
(b) Retarding Admixtures
(c) Accelerating Admixtures.
(d) Water Reducing and Retarding Admixtures.
(e) Water Reducing and Accelerating Admixtures.
(f) Permeability reducing (water proofing) Admixtures.

3.1.2.2 **Liquid Admixtures:** Admixtures introduced into the concrete as liquids generally fall into the following categories:-
(a) Air Entraining.
(b) Water Reducing.
(c) Water Reducing Retarders.
(d) Retarders.
(e) Water Reducing Accelerators.
(f) Accelerators.

3.1.2.3 The dosage of above admixtures may vary according to manufacturer’s specification.

3.1.2.4 No admixtures shall be accepted for use in concrete unless these are tested in accordance with
IS 9103 and the test results are approved by the Engineer-in-Charge.

3.2. CEMENT CONCRETE

3.2.1 Grades of Cement Concrete

The grade designation of concrete shall be as below:

**TABLE 3.6 Grades of concrete**

<table>
<thead>
<tr>
<th>Group</th>
<th>Grade Designation</th>
<th>Specified characteristic compressive strength of 150 mm Cube at 28 Days in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordinary Concrete</td>
<td>M10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>M20</td>
<td>20</td>
</tr>
<tr>
<td>Standard Concrete</td>
<td>M25</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>M30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>M35</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>M40</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>M45</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>M50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>M55</td>
<td>55</td>
</tr>
<tr>
<td>High Strength Concrete</td>
<td>M60</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>M65</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>M70</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>M75</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>M80</td>
<td>80</td>
</tr>
</tbody>
</table>

**Notes:**

1. In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm².

2. For concrete of compressive strength greater than M55, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.

3.2.1.1 Concrete Mix Proportion: The free water – cement ratio is an important factor in governing the durability of concrete and should always be the lowest value. Appropriate values for minimum cement content and the maximum free water-cement ratio are given in Table 3.7 for different exposure conditions. The minimum cement content and maximum water-cement ratio apply to 20mm nominal maximum size aggregate. For other sizes of aggregate they should be changed as given in Table 3.8.

The characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fail.

**TABLE 3.7**

Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal; Maximum Size

<table>
<thead>
<tr>
<th>S No.</th>
<th>Exposure</th>
<th>Plain Concrete</th>
<th>Reinforced Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum Cement Content kg/m³</td>
<td>Maximum Free Water Cement Ratio</td>
</tr>
<tr>
<td>(i)</td>
<td>Mild</td>
<td>220</td>
<td>0.60</td>
</tr>
<tr>
<td>(ii)</td>
<td>Moderate</td>
<td>240</td>
<td>0.60</td>
</tr>
<tr>
<td>(iii)</td>
<td>Severe</td>
<td>250</td>
<td>0.50</td>
</tr>
<tr>
<td>(iv)</td>
<td>Very Severe</td>
<td>260</td>
<td>0.45</td>
</tr>
<tr>
<td>(v)</td>
<td>Extreme</td>
<td>280</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Notes:

1. Cement content prescribed in this Table is irrespective of the grades of cement. The additions such as fly or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio, if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolana and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2. Minimum grade for plain concrete under mild exposure condition is not specified.

3. The above minimum cement content and maximum water cement ratio apply only to 20 mm nominal maximum size aggregate. For other sizes of aggregate, these should be changed as per Table 3.8.

The minimum grade of concrete for plain and reinforced concrete shall be as per Table 3.7 & 3.8.

<table>
<thead>
<tr>
<th>Table No.- 3.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustments to Minimum Cement Contents other Than 20mm Nominal Maximum Size</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal Maximum Aggregate Size</th>
<th>Adjustments to Minimum Cement Contents in Table 3.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(i)</td>
<td>10</td>
<td>+ 40</td>
</tr>
<tr>
<td>(ii)</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>(iii)</td>
<td>40</td>
<td>- 30</td>
</tr>
</tbody>
</table>

3.2.1.2 Concrete of grades lower than those given in Table 3.7 may be used for lean concrete, foundation for masonry walls or temporary reinforced concrete construction.

3.2.2 Workability of Concrete

The concrete mix proportion chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Degree of workability is tested by slump test.

3.2.2.1 Slump test is mandatory tests for concrete and shall be done as per procedure given below:

**Apparatus:** Mould shall consist of a metal frustum of cone having the following internal dimensions:

- Bottom diameter ............................................................... 20 cm
- Top diameter ................................................................................ 10 cm
- Height ......................................................................................... 30 cm

The mould shall be of a metal other than brass and aluminum of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide attachment may be used. Tamping rod shall be of steel or other suitable material 16 mm in diameter 60 mm long and rounded at one end.

**Procedure:** The internal surface of the mould shall be thoroughly cleaned and free form superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth horizontal, rigid; and non-absorbent surface viz. leveled metal plate. The operator shall hold the mould firmly in place while it is being filled with test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of height of mould. Each layer shall be tamped with twenty five strikes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the underlying layer. The bottom layer shall be tamped through out its depth. After the top layer has been rodded, the concrete shall be struck off level with trowel or the tamping rod, so that the mould is exactly filled. Any mortar which shall leak out between the mould and the base plate shall be cleaned away. The...
mould shall be removed from the concrete immediately after filling by raising it slowly and carefully in a vertical direction. The moulded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of specimen. The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling.

Result: The slump shall be recorded in terms of millimeters of subsidence of the specimen during the test. Any slump specimens which collapses or shears off laterally give incorrect result. If this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.

### 3.2.2.2 Suggested ranges of workability of concrete measured in accordance with IS 1199 are given below:

<table>
<thead>
<tr>
<th>Placing Conditions</th>
<th>Degree of Workability</th>
<th>Slump (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blinding concrete: shallow sections: Pavements using pavers</td>
<td>Very low</td>
<td>See 3.2.2.2</td>
</tr>
<tr>
<td>Mass concrete: Lightly reinforced sections in slabs, beams, wall, columns, floors</td>
<td>Low</td>
<td>25-75</td>
</tr>
<tr>
<td>Hand placed pavements; canal lining; Strip footing</td>
<td>Medium</td>
<td>50-100</td>
</tr>
<tr>
<td>Heavily reinforced sections in slabs, beams, walls, columns;</td>
<td>Medium</td>
<td>75-100</td>
</tr>
<tr>
<td>Slip form work: Pumped concrete</td>
<td>Medium</td>
<td>100-150</td>
</tr>
<tr>
<td>Trench fill</td>
<td>High</td>
<td>175</td>
</tr>
<tr>
<td>Tremie concrete</td>
<td>Very High</td>
<td></td>
</tr>
</tbody>
</table>

In the ‘very high’ category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

### Note: -
For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

### 3.2.2.3 In the ‘very low’ category of workability where strict control is necessary, for example, pavement quality concrete, measurement of workability and determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

### 3.2.2.4 Compressive Strength Test of Concrete:
**Cube Test for Compressive Strength of Concrete - Mandatory Lab Test:**

**Mandatory tests shall be:-**
One sample (consisting of six cubes 15x15x15 cm shall be taken for every 20 cum or part thereof concrete work ignoring any part less than 5cum or as often as considered necessary by the Engineer-in-Charge. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site in the Performa as below:-

### REGISTER OF WORK TEST FOR CONCRETE

<table>
<thead>
<tr>
<th>(a) Name of work</th>
<th>Concrete mix, (by volume)</th>
<th>Compressive strength in kg/cm² on 7 days</th>
<th>Compressive strength in kg/cm² on 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b) Name of Contractor</td>
<td>1:1:2</td>
<td>210</td>
<td>315</td>
</tr>
<tr>
<td>(c) Agreement No.</td>
<td>1:1.5:3</td>
<td>175</td>
<td>265</td>
</tr>
<tr>
<td>(d) Sample No.</td>
<td>1:2:4</td>
<td>140</td>
<td>210</td>
</tr>
<tr>
<td>(e) Identification mark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f) Portion of work any quantity represented by sample</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The casting of cubes, concrete used for cubes and all other incidental charge, such are curing, carriage to the testing laboratory shall be borne by the contractors. The testing fee for the cubes, if any, shall be borne by the department.

A-1 Test Procedure

A-1.1 Mould
The mould shall be of size 15 cm x 15 cm x 15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm size of mould shall be specified by the Engineer-in-Charge, keeping in view the fact that the length of size of mould should be about four times the size of aggregate.

The moulds for test specimens shall be made of non-absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one percent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5 mm thick or plain metal not less than 12 mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

Note: Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized.

A-1.2 Sample of Concrete
Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by Engineer-in-Charge. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should be spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of moulding of the specimen to counteract segregation. The concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete this sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen. The sampling shall be spread as evenly as possible throughout the day. When wide changes occur during concreting, additional sample shall be taken if so desired by the Engineer-in-Charge.

A-1.3 Preparation of Test Specimens
The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained as described under the test specimen shall be immediately moulded by one of the following methods as indicated below:

When the Job concrete is compacted by manual methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge do the mould as the concrete there sided from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 35 times with 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be rodded through its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thicker a machined plate. The whole process of moulding shall be carried out in such a manner as to preclude the change of the water cement ratio of the concrete, by loss of water.
either by leakage from the bottom or over flow from the top of the mould.

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand rolling as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall only be used when the concrete is required to be compacted in layers. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for top extent that there will be no mortar loss during vibrations. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then the struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of water-cement ratio of the concrete by loss of water, either by leakage for the bottom or over flow from the top of the mould.

**A-1.4 Curing and Storage of Test Specimen**

In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed a storage box so constructed and kept on the work site that its air temperature when containing concrete specimens shall remain 22°C to 33°C. Other suitable means which provide such a temperature and moisture conditions may be used.

Note:- It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24°C to 30°C until the time of test. If storage in water is desired, a saturated lime solution shall be used.

**A-1.5 Testing**

The specimens shall be tested in accordance with procedure as described below:

(a) The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.

(b) Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.

(c) The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

(d) The load shall be applied axially without shock at the rate of approximately 140 kg. per sq.cm. per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq. cm. using the area computed from the measured dimension of the test specimen. The type of failure and Appearance of the concrete shall be noted.

**3.2.3 Concrete Mix**

This mix proportions shall be selected to ensure the workability of the fresh concrete and when concrete is hardened, it shall have the required strength, durability and surface finish.

The determination of the proportions of cement, aggregates and water to attain the required strengths shall be made as follows:
(a) Designing mix: Where the mix proportion is fixed by designing the concrete mixes shall be called 'Design mix concrete', for details reference may be made in Chapter 4 of RCC.

(b) Nominal concrete mix: Where nominal concrete mix is adopted shall be called 'Nominal mix concrete'. Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of Engineer-in-Charge, which, however, is likely to involve higher cement content.

3.2.3.2 Nominal Mix Concrete: Nominal Mix Concrete may be used for concrete of M20 or lower. The proportions of materials for nominal mix concrete shall be in accordance with Table 3.9 as below.

The cement content of the mix specified in Table 3.9 for any nominal mix shall be proportionately increased if the quantity of water in the mix has to be increased to overcome the difficulty or placement and compaction, so that the water cement ratio as specified is not exceeded.

### TABLE 3.9

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Total Quantity of Dry Aggregates by Mass per 50 kg of cement, to be taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, Kg. Max</th>
<th>Proportion of Fine Aggregate to Coarse Aggregate (by Mass)</th>
<th>Quantity of Water per 50 kg of Cement, max Ltr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>800</td>
<td>Generally 1:2 but</td>
<td>60</td>
</tr>
<tr>
<td>M7.5</td>
<td>625</td>
<td>subject to an upper</td>
<td>45</td>
</tr>
<tr>
<td>M10</td>
<td>480</td>
<td>limit of 1:1½ and</td>
<td>34</td>
</tr>
<tr>
<td>M15</td>
<td>330</td>
<td>a lower limit of 1½</td>
<td>32</td>
</tr>
<tr>
<td>M20</td>
<td>250</td>
<td>1:2½</td>
<td>30</td>
</tr>
</tbody>
</table>

**Note:** -
1) The proportion of the fine to coarse aggregate should be adjusted from upper limit progressively as the grading of fine aggregate becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.
2) Quantity of water required from durability point of view may be less than the value given above.

**Example**

For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be 1:1½, 1:2 and 1:2½ for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

3.2.4 Batching

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixed on any site or in any one plant. In batching concrete, the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass; liquid admixture may however be measured in volume or mass: water shall be weighed or measured by volume in a calibrated tank (see also IS 4925).

Ready-mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (see IS 4926).

(a) Except where it can be shown to the satisfaction of the Engineer-in-Charge that supply of properly graded aggregate of uniform quality can be maintained over a period of work, the grading aggregate should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions when required, the different sizes being stocked in separate stock-piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the specified grading is maintained.

(b) The accuracy of the measuring equipment shall be within ± 2 % of the quantity of cement being measured and within ± 3 % of the quantity of aggregate, admixtures and water being measured.
(c) Proportion/Type and grading of aggregates shall be made by trial in such a way so as to obtain densest possible concrete. All ingredients of the concrete should be used by mass only.

(d) Volume batching may be allowed only where weigh-batching is not practicable and provided accurate used in concrete have earlier been established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by Engineer-in-Charge to ensure that the specified grading is maintained.

(e) It is important to maintain the water cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS 2386 (Part 3) may be referred to. To allow for the variation in mass for aggregate due to variations in their moisture content; suitable adjustments in the masses of aggregates shall be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in Table 3.10.

<table>
<thead>
<tr>
<th>TABLE 3.10 Surface Water Carried by Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only is case of Nominal Mix</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SI No.</th>
<th>Aggregate</th>
<th>Approximate Quantity of Percent by mass</th>
<th>Surface Water l/m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Very wet sand</td>
<td>7.5</td>
<td>120</td>
</tr>
<tr>
<td>(ii)</td>
<td>Moderately wet sand</td>
<td>5.0</td>
<td>80</td>
</tr>
<tr>
<td>(iii)</td>
<td>Moist sand</td>
<td>2.5</td>
<td>40</td>
</tr>
<tr>
<td>(iv)</td>
<td>1) Moist gravel or crushed rock</td>
<td>1.25-2.5</td>
<td>20-40</td>
</tr>
</tbody>
</table>

1) Coarser the aggregate, less the water it will carry.

(f) No substitutions in materials used on the work or alteration in the established proportions except as permitted in 3.2.4.d and 3.2.4.e shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

3.2.5 Concrete Mixing:

3.2.5.1 Mixing in mechanical batch type concrete mixers conforming to IS 1791: Concrete shall be having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical break down of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the Engineer-in-Charge in writing subject to adding 10% extra cement. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials.

3.2.5.2 Hand Mixing: When hand mixing is permitted, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials.

3.2.5.3 Mixing Time: For guidance, the mixing time may be 1½ to 2 minutes, for hydrophobic cement it may be taken as 2½ to 3 minutes.

3.2.5.4 Power Loader: Mixer will be fitted with a power loader.

3.2.5.5 Mixing Efficiency of Mixer: The mixer shall be tested under normal working conditions in accordance with the method specified in IS 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete. The percentage variation between the quantities...
of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two half of the batch shall not be more than the following limits:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>8%</td>
</tr>
<tr>
<td>Fine aggregate</td>
<td>6%</td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>5%</td>
</tr>
</tbody>
</table>

### 3.2.5.6 Machine Mixing Process:

The mixer drum shall be flushed clean with water.

Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement.

Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for at least four turns of the drum.

While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the Engineer-in-Charge. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained.

Mixing shall be done for at least two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed. The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed cleaned with water.

### 3.2.5.7 Hand Mixing Process:

When hand mixing has been specifically permitted in exceptional circumstances by the Engineer-in-Charge in writing, subject to adding 10% extra cement, it shall be carried out on a smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by showlling and turning till the coarse aggregate gets evenly distributed the cement sand mixture.

Three quarters of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

### 3.2.5.8 Transportation and Handling:

Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability. During hot or cold weather, concrete shall be transported in deep containers, other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

### 3.2.6 Placing

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude .segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains. As a general guidance, the maximum free fall of concrete may be taken as 1.5 meter.

### 3.2.7 Compaction

The concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical vibrators shall conform to IS 2505, IS 2506, IS 2514 and IS 4656 and to prevent segregation, over vibration shall be avoided. Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.
3.2.8 Construction Joints
The concreting shall be carried out continuously up to construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the Engineer-in-Charge. Number of such joints shall be kept minimum. Joints shall be kept as straight as possible. Construction joints should comply with IS 11817.

(a) When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints, neat cement slurry, of workable consistency by using 2 kgs of cement per sqm shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete.

(b) Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement/sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work. Particular attention being paid to corners and close spots; work, thereafter, shall proceed in the normal way.

3.2.9 Concreting under Special Conditions

(a) Work in Extreme Weather Conditions: During hot and cold weather, the concreting shall be done as per the procedure set out in IS 7861 (Part I)-1975 and IS 7861 (Part II)-1981 respectively. Concreting shall not be done when the temperature falls below 4.5°C. In cold weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38°C.

(b) Under Water Concreting: The concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be submitted to and approved by the Engineer-in-Charge before the work is started.

Under water concrete should have a slump recommended in 3.2.2. The water-cement ratio shall not exceed 0.6 and may need to be smaller, depending on the grade of concrete or the type of chemical attack. For aggregates of 40 mm maximum particle size, the cement content shall be at least 350 kg/m³ of concrete.

3.2.10 Curing
Curing is the process of preventing loss of moisture from the concrete. The following methods shall be employed for effecting curing.

(a) Moist Curing: Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 7 days from the date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

(b) Membrane Curing: Approved curing compounds may be used in lieu of moist curing with the permission of the Engineer-in-Charge. Such compound shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membrane such as polythene sheet covering the concrete surface may also be used to provide effective barrier against evaporation.

(c) Freshly laid concrete shall be protected from rain by suitable covering.

(d) Over the foundation concrete, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall be continued along with the masonry work for at least 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing period of base concrete is over but the curing of base concrete shall be continued along with the top layer of flooring for a minimum period of 7 days.
3.2.11 Form Work
Form work shall be as specified in R.C.C. chapter and shall be paid for separately unless otherwise specified.

3.2.12 Finishes
Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

3.2.13 Durability of Concrete
A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service. The materials and mix proportions shall be such as to maintain its integrity and, if applicable, to protect reinforcement from corrosion.

The factors influencing durability include:
(a) The environment;
(b) The cover to embedded steel;
(c) The type and quality of constituent materials;
(d) The cement content and water/cement ratio of the concrete;
(e) Workmanship, to obtain full compaction and efficient curing;
(f) The shape and size of the member.

3.2.13.1 Requirements for Durability
(a) General Environment: The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in Table 3.11.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Environment</th>
<th>Exposure Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Mild</td>
<td>Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.</td>
</tr>
<tr>
<td>(ii)</td>
<td>Moderate</td>
<td>Concrete surfaces sheltered from severe rain. Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water.</td>
</tr>
<tr>
<td>(iii)</td>
<td>Severe</td>
<td>Concrete surfaces exposed to severe rain, alternate wetting and drying.</td>
</tr>
<tr>
<td>(IV)</td>
<td>Very severe</td>
<td>Concrete in contact with or buried under aggressive sub-soil/ground water.</td>
</tr>
<tr>
<td>(V)</td>
<td>Extreme</td>
<td>Members in direct contact with liquid/solid aggressive chemicals.</td>
</tr>
</tbody>
</table>

Note: For the purpose of determining exposure conditions, all places within a distance of 10 kms. of coastal line, sea front would be treated as coastal area.

(b) Freezing and Thawing: Where freezing and thawing actions under wet conditions exist, enhanced durability can be obtained by the use of suitable air entraining admixtures. When concrete lower than grade M50 is used under these conditions, the mean total air content by volume of the fresh concrete at the time of delivery into the construction should be:

<table>
<thead>
<tr>
<th>Nominal Maximum Size Aggregate</th>
<th>Entrained Air Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5±1</td>
</tr>
<tr>
<td>40</td>
<td>4±1</td>
</tr>
</tbody>
</table>

(c) Exposure to Sulphates Attack: For the very high Sulphates concentration in Class 5 conditions given in Table 3.12, some forms of lining such as polyethylene or polychloroprene sheet; or surface coating based on asphalt, chlorinated rubber, epoxy; or polyurethane materials should also be used to prevent access by the Sulphates solution.

(d) Chlorides in Concrete: The total amount of chlorides content (as Cl) in the concrete at the time of placing shall be as under:
(i) Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete

(ii) Reinforced concrete or plain concrete containing embedded metal

(iii) Concrete not containing embedded metal or any material requiring protection from chloride

(e) Sulphates in Concrete: The total water-soluble Sulphates content of the concrete mix, expressed as SO\(_3\) should not exceed 4% by mass of the cement in the mix. The Sulphates content should be calculated as the total from the various constituents of the mix. The 4% limit does not apply to concrete made with super Sulphates cement complying with IS 6909.

### TABLE 3.12
Requirements for Concrete Exposed to Sulphates Attack

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Sl. No.</th>
<th>Class</th>
<th>Concentration of Sulphates, Expressed as SO(_3) Concrete.</th>
<th>Type of Cement</th>
<th>Dense, Fully compacted made with 20 mm nominal maximum size Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>In Soil</td>
<td>In Ground Water (g/l)</td>
<td>Total SO(_3) (%)</td>
</tr>
<tr>
<td>(i)</td>
<td>1</td>
<td>Traces (&lt;0.2)</td>
<td>Less than 1.0</td>
<td>Less than 0.3</td>
<td>Ordinary Portland cement or Portland slag cement or Portland pozzolana cement</td>
</tr>
<tr>
<td>(ii)</td>
<td>2</td>
<td>0.2 to 0.5</td>
<td>1.0 to 1.9</td>
<td>0.3 to 1.2</td>
<td>Ordinary Portland cement or Portland slag cement or Portland pozzolana cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Super Sulphated cement or Sulphates resisting Portland cement</td>
</tr>
<tr>
<td>(iii)</td>
<td>3</td>
<td>0.5 to 1.0</td>
<td>1.9 to 3.1</td>
<td>1.2 to 2.5</td>
<td>Supersulphated cement or Sulphates resisting Portland cement</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Portland Pozzolana cement or Portland slag cement</td>
</tr>
<tr>
<td>(iv)</td>
<td>4</td>
<td>1.0 to 2.0</td>
<td>3.1 to 5.0</td>
<td>2.5 to 5.0</td>
<td>Supersulphated or Sulphates resisting Portland cement</td>
</tr>
<tr>
<td>(V)</td>
<td>5</td>
<td>More than 2.0</td>
<td>More than 5.0</td>
<td>More than 5.0</td>
<td>Sulphates resisting Portland cement or Supersulphated cement with protective coating</td>
</tr>
</tbody>
</table>

Notes
1. Cement content given in this Table is irrespective of grades of cement.
2. Use of Super sulphated cement is generally restricted where the prevailing temperature is above 40°C.
3. Super sulphated cement gives an acceptable life provided that the concrete is dense and prepared with a water-cement ratio of 0.4 or less, in mineral acids, down to pH 3.5.
4. The cement contents given in col. 7 of this Table are the minimum recommended. For SO\(_3\) contents near the upper limit of any class, cement contents above these minimum are advised.
5. For severe conditions, such as thin sections under hydrostatic pressure on one side only and sections partly immersed, considerations should be given to a further reduction of water-cement ratio.
6. Portland slag cement conforming to IS 455 with slag content more than 50% exhibits better Sulphates resisting properties.
7. Where chloride is encountered along with Sulphates in soil or ground water, ordinary Portland cement with C\(_3\) A content from 5% to 8% shall be desirable to be used in concrete, instead of...
Sulphates resisting cement. Alternatively, Portland slag cement conforming to IS 455 having more than 50% slag or a blend of ordinary Portland cement and slag may be used provided sufficient information is available on performance of such blended cements in these conditions.

### 3.2.14 Measurements

(a) Dimensions of length, breadth and thickness shall be measured correct to nearest cm. except for the thickness of slab and partition which shall be measured to nearest 5 mm. Areas shall be worked out to nearest 0.01 sqm and the cubic contents of consolidated concrete shall be worked out to nearest 0.01 cum. Any work done in excess over the specified dimension or sections shown in the drawing shall be ignored.

(b) Concrete work executed in the following conditions shall be measured separately:
1. Work in or under water
2. Work in liquid mud
3. Work in or under foul positions

(c) *Cast-in-situ concrete* and or precast concrete work shall be measured in stages described in the item of work, such as:
1. At or near the ground level
2. Upto specified floor level
3. Between two specified floor levels
4. Upto specified height above or depth below plinth level/defined datum level.
5. Between two specified heights or depths with reference to plinth/defined datum level.

(d) No deduction shall be made for the following:
1. Ends of dissimilar materials for example beam, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sq cm in cross sections.
2. Opening upto 0.1 sq meter (1000 sq.cm)
3. Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sqcm each in cross sectional areas.
4. Small voids such as shaded portions in Figure A to J below when these do not exceed 40 sq cm each in cross section.

**Note:** In calculating area of opening, the thickness of any separate lintel or sill shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

Area of Fig. A to G shall be \( L \times B \)
Area of Fig. H & J shall be \( L \times \{\text{Average of } B \text{ and } B'\} \)

Diagram

(e) *Cast-in-situ* and *precast* concrete work shall be measured separately.
Cast-in-situ concrete shall be classified and measured as follows:

1. Foundation, footings, bases for columns
2. Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.
3. Shelves
4. Slabs
5. Chajjas including portions bearing on the wall
6. Lintels, beams and bressummers
7. Columns, piers abutments, pillars, post and strut
8. Stair case including stringer beams but excluding landings.
9. Balustrades, newels and sailing
10. Spiral staircase (including landings)
11. Arches
12. Domes, vaults
13. Shell roof, arch ribs and folded plates
15. Breast walls, retaining, walls, return walls
16. Concrete filling to precast components
17. Krebs, steps and the like
18. String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like
19. Cornices and moulded windows sills.
20. Louvers, fins, fascia.

Precast cement concrete solid article shall be measured separately and shall include use of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position in cement mortar 1:2 (1 cement: 2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as under:

<table>
<thead>
<tr>
<th>Classifications</th>
<th>Method of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Wall panels</td>
<td>In square meters stating the thickness.</td>
</tr>
<tr>
<td>(b) String or lacing courses, coping, bed plates, plain windows sills, shelves, louvers, steps etc.</td>
<td>In cubic meters.</td>
</tr>
<tr>
<td>(c) Krebs, edgings etc.</td>
<td>In cubic meters.</td>
</tr>
<tr>
<td>(d) Solid block work</td>
<td>In square meters stating the thickness or in cubic meters.</td>
</tr>
<tr>
<td>(e) Hollow block work</td>
<td>In square meters stating the thickness or in cubic meters.</td>
</tr>
<tr>
<td>(f) Light weight partitions</td>
<td>In square meters stating the partition’s thickness.</td>
</tr>
</tbody>
</table>

3.2.15 Rate
The rate is inclusive of the cost of labour and materials involved in all the operations described above.

3.3 CEMENT- FLY ASH CONCRETE
Fly ash concrete shall be prepared by mixing graded coarse aggregate of nominal size as specified with fine aggregate, ordinary Portland cement and fly ash in specified proportions with required quantity of water. The recommended composition of cement fly ash concrete is as under:
TABLE 3.15 Fly Ash Concrete Mixes

<table>
<thead>
<tr>
<th>Composition (Dry Volume)</th>
<th>Proportion (Dry Volume)</th>
<th>Compressive Strength at seven days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Concrete (1:5:10)</td>
<td></td>
<td>28 kg/cm²</td>
</tr>
<tr>
<td>Cement (Ordinary Portland)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Fly ash</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Stone aggregate</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean Concrete (1:4:8)</td>
<td></td>
<td>37 kg/cm²</td>
</tr>
<tr>
<td>Cement (Ordinary Portland)</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Fly ash</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Stone aggregate</td>
<td>9.0</td>
<td></td>
</tr>
</tbody>
</table>

Note: No fly ash is to be added to Portland Pozzolana cement in any case which itself contains fly ash.

3.3.1 Proportioning
Proportioning shall be done by volume. Boxes of suitable size shall be used for measuring fly ash, sand and aggregate. The internal dimensions of the boxes shall be generally 35x25x40 cm deep or as otherwise approved by the Engineer-in-charge. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand; allowances for bulk age shall be made as given in the chapter for mortar.

3.3.2 Mixing shall be as specified in 3.2.5 except that the fly ash shall be placed in the hopper before cement in case of machine mixing.

3.3.3 Placing and compaction, curing, form work and measurement shall be as specified in para 3.2.6 to 3.2.7 and 3.2.10 to 3.2.15

3.3.7 Rate
Rate shall include the cost of materials and labour involved in all the operations described above.

3.4 DAMP PROOF COURSE
3.4.1 Cement Concrete Layer
This shall consist of cement concrete of specified proportions and thickness. The surface of brick or stone masonry work shall be leveled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall consist of steel forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without honey-coming. Continuity shall be maintained while laying the cement concrete layer and laying shall be terminated only at the predetermined location where damp proof course is to be discontinued. There shall be no construction joints in the Damp Proof Course.

3.4.2 Curing
Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

3.4.3 Application of Hot Bitumen
Where so directed, hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. Bitumen of penetration A 90 or equivalent where used shall be heated to a temperature of 160° ± 5°C. The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere. It will be paid for separately.
3.4.4 Water Proofing Materials
Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer’s specification stating the quantity of water proofing material in liters or kg per 50 kg or cement and will be paid for separately.

3.4.5 Measurements
The length and breadth shall be measured correct to a cm and its area shall be calculated in square meters correct to two places of decimal. The depth shall not be less than the specified thickness at any section.

3.4.6 Rate
The rate is inclusive of the cost of materials and labour involved in all the operations described above except for the applications of a coat of hot bitumen and addition of water proofing materials which shall be paid for separately, unless otherwise specified.
# LIST OF BUREAU OF INDIAN STANDARDS CODES

<table>
<thead>
<tr>
<th>S.No.</th>
<th>IS. No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>IS 383</td>
<td>Specification for coarse and fine aggregate from natural sources for concrete.</td>
</tr>
<tr>
<td>2.</td>
<td>IS 456</td>
<td>Plain and reinforced concrete - Code of practice</td>
</tr>
<tr>
<td>3.</td>
<td>IS 516</td>
<td>Method of test for strength of concrete</td>
</tr>
<tr>
<td>4.</td>
<td>IS 1199</td>
<td>Method of sampling and analysis of concrete</td>
</tr>
<tr>
<td>5.</td>
<td>IS 1200 (Part II)</td>
<td>Method of measurement of building and civil engineering work (concrete work)</td>
</tr>
<tr>
<td>6.</td>
<td>IS 1322</td>
<td>Specification for bitumen felt for water proofing and damp proofing.</td>
</tr>
<tr>
<td>7.</td>
<td>IS 1791</td>
<td>General requirements for batch type concrete mixers</td>
</tr>
<tr>
<td>8.</td>
<td>IS 2386</td>
<td>Method of test for aggregates for concrete</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) Part I - Particle size and shape</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Part II - Estimation of harmful materials and organic impurities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Part III - Specific gravity, density, voids absorption and bulking.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Part IV - Mechanical properties.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) Part V - Soundness</td>
</tr>
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<td>9.</td>
<td>IS 2505</td>
<td>General requirements for concrete vibrators - immersion type.</td>
</tr>
<tr>
<td>10.</td>
<td>IS 2506</td>
<td>General requirements for concrete vibrators - screed board concrete vibrators</td>
</tr>
<tr>
<td>11.</td>
<td>IS 2645</td>
<td>Specification for integral water proofing compounds for cement mortar and concrete</td>
</tr>
<tr>
<td>13.</td>
<td>IS 3812</td>
<td>Specification for fly ash for use as pozzolana and admixture in cement mortar and concrete.</td>
</tr>
<tr>
<td>17. -</td>
<td>IS 9103</td>
<td>Specification for concrete admixtures</td>
</tr>
</tbody>
</table>
4.0 REINFORCED CEMENT
<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>General</td>
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<td>4.1-4.1.2</td>
<td>Use of fly ash cement in concrete.</td>
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<td>4.2-4.2.3.2</td>
<td>Mandatory tests for Reinforced Concrete.</td>
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<td>4.3-4.3.6</td>
<td>Inspection and Testing of structures.</td>
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<tr>
<td>4.4-4.4.4</td>
<td>Types of steel, Nominal mass/weight and it's tolerance, stacking and storage.</td>
</tr>
<tr>
<td>4.5-4.5.7</td>
<td>Form work, Centering &amp; shuttering, General Requirement, Design &amp; tolerance in Construction, Removal of formwork and stripping time surface treatment, Inspection of form work, classification of measurement and rates.</td>
</tr>
<tr>
<td>4.6-4.6.5</td>
<td>General Requirements of Reinforcement, its Assembly Bonds and hooks placing of reinforcement.</td>
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<tr>
<td>4.7-4.7.13.2</td>
<td>Consistency of concrete, Construction Joints, Expansion, Joints curing, finishing, testing, Measurements, and tolerances.</td>
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<td>4.8-4.8.6</td>
<td>Encasing Rolled steel sections, General Requirements, Wrapping formwork, concreting, Measurements and Rates.</td>
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<td>4.9-4.9.2</td>
<td>Precast Reinforcement concrete, General Requirements.</td>
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<tr>
<td>4.10-4.10.3</td>
<td>Precast Cement Concrete Jali, Fixing, Measurements and rates.</td>
</tr>
<tr>
<td>4.11-4.11.6.2</td>
<td>Concrete mix design proportioning standard deviation, acceptance criteria, compressive strength, Flexural strength, and tests for approval of design mix.</td>
</tr>
<tr>
<td>4.12-4.12.7.4</td>
<td>Ready Mix concrete as per IS 4926, General requirements, Basis of supply, Transport of concrete, Time in transportation, use of chemical Admixtures, selection and approval of materials sampling and testing of Ready Mixed concrete, workability and specified strength production and delivery, Storage and Handling, Delivery ticket, Quality control and performance.</td>
</tr>
<tr>
<td>4.13.2.7</td>
<td>Placing concrete by pumping, Types of pumps, and pipe lines and lubricating pipe line.</td>
</tr>
<tr>
<td>4.14-4.14.5</td>
<td>Guide lines for field practice, General precautions, Information to be submitted with Bid, sampling and testing, compacting factor, consistency of concrete, sampling and testing of Hardend concrete and non-destructive tests.</td>
</tr>
<tr>
<td></td>
<td>Details of Expansion Joint at floor and sun shade.</td>
</tr>
<tr>
<td></td>
<td>Section of twin Beam with twin columns. Slab and “T” beam construction of long length.</td>
</tr>
<tr>
<td></td>
<td>Details of expansion joint covering on outer face of columns, Details of Expansion joint at roof and floor junction.</td>
</tr>
<tr>
<td></td>
<td>Details of Expansion joint at wall &amp; beam junction.</td>
</tr>
<tr>
<td></td>
<td>List of Bureau of Indian Standard Codes</td>
</tr>
</tbody>
</table>
4.0 GENERAL

(i) Reinforced cement concrete work may be cast in situ or precast and may be as per direction of Engineer-in-charge. This work shall comprise from work, reinforcement and concreting which may be separately or collectively as per description of the item of work. Material Components are water, cement, fine sand and course aggregate. Water, cement, fine sand and coarse aggregate shall be as specified in chapter 02 mortars and chapter 03 concrete works as applicable.

(ii) IS 456-2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:

(a) The concrete mix design shall be done as "Design Mix Concrete" as prescribed in clause-9 of IS 456.

(b) Concrete shall be manufactured in accordance with clause 10 of IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete person for concrete quality assurance to be available during manufacture of concrete for certification of quality of concrete.

(iii) Minimum M-25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.

(iv) The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.

(v) To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture. If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and/or PPC received from different sources shall be ensured by trials.

(vi) Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

4.1 Use of Fly ash Cement in concrete :-

4.1.1 Use of Fly ash Admixed Cement Concrete (FACC) in RCC structures

There shall be no bar on use of FACC in RCC structures subject to following additional conditions.

(i) Fly ash shall have its chemical characteristics and physical requirements etc. conforming to IS 3812 (Part I & II) and shall be duly certified.

(ii) To ensure uniform blending of fly ash with cement in conformity with IS 456, a specific facility needs to be created at site with complete computerized automated process control to achieve design quality or with similar facility from Ready Mix Concrete (RMC) plants.

(iii) As per IS 1489 (Part-I) maximum 35% of OPC by mass is permitted to be substituted with fly ash conforming to IS 3812 (Part-I) and same is reiterated.

(iv) Separate storage for dry fly ash shall be provided. Storage bins or silos shall be weather proof and permit a free flow and efficient discharge of fly ash. The filter or dust control system provided in the bins or silos shall be of sufficient size to allow delivery of fly ash maintained at specified pressure to prevent undue emission of fly ash dust, which may interfere weighing accuracy.

4.1.2 Use of Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures

(i) Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS 1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix concrete for structural use in RCC.

(ii) Till the time, BIS makes it mandatory to print the percentage age of fly ash on each bag of cement, the certificate from the PPC manufacture indicating the same shall be insisted upon before allowing use of such cements in works.
(iii) While using PPC for structural concrete work, no further admixing of fly ash shall be permitted.

4.2 Test of Reinforcement Concrete: List of Mandatory Tests is given below.

<table>
<thead>
<tr>
<th>Type of Mix</th>
<th>Material</th>
<th>Test</th>
<th>Field/ laboratory test</th>
<th>Test procedure</th>
<th>Min, quantity of material for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced cement concrete (Nominal Mix)</td>
<td>(a) Slump test</td>
<td>Field/Lab</td>
<td>As per Chapter 3 clause No……</td>
<td>(i) 5 cum in case of column (ii) 20 cum for slabs, beams and connected columns (iii) 20 cum for other R.C.C. work for all other small items and where R.C.C. done in a day is less than 5 cum test may be carried out as required by Engineer-in-Charge</td>
<td>(i) Every 5 cum of part thereof (ii) Every 20 cum or part thereof (iii) -Do-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Cube Test</td>
<td>Lab</td>
<td>As per Chapter 3 clause No……</td>
<td>(i) 5 cum in case of column (ii) 20 cum for slabs, beams and connected columns (iii) 20 cum for other R.C.C. work for all other small items and Where R.C.C. done in a day is less than 5 cum test may be carried out as required as required by Engineer-in-Charge</td>
<td>(i) Every 5 cum or part thereof (ii) Every 20cum or part thereof (iii) -Do-</td>
<td></td>
</tr>
<tr>
<td>Reinforced Cement Concrete (Design Mix)</td>
<td>Coarse Aggregate</td>
<td></td>
<td>50 cum or part thereof &amp; also on each change of source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fine Aggregate</td>
<td></td>
<td>50 cum or part thereof &amp; also on each change of source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cement</td>
<td></td>
<td>50 MT or on each change of source</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh Concrete</td>
<td>(a) Slump test</td>
<td>Field/ laboratory</td>
<td>Clause 4.4.10.5 (D) 1</td>
<td>10 cum</td>
<td>50 cum for R.C.C. work including in all</td>
<td></td>
</tr>
</tbody>
</table>

Table No. 4.1 LIST OF MANDATORY TESTS
### Test Specimen

Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.
4.2.2 Test Results of Sample
The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than $\pm 15$ percent of the average. If more, the test results of the sample are invalid.

4.2.3 Acceptance Criteria
4.2.3.1 Compressive Strength
The concrete shall be deemed to comply with the strength requirements when both the following condition are met:
(a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 4.2.
(b) Any individual test result complies with the appropriate limits in col 3 of Table 4.2.

<table>
<thead>
<tr>
<th>Specified Grade</th>
<th>Mean of the Group of 4 No-Overlapping Consecutive Test Results in N/mm²</th>
<th>Individual Test Results in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 15</td>
<td>$\geq \frac{c_k}{c_k} + 0.825 \times$ established standard deviation (rounded off to nearest 0.5 N/mm²) Or $\frac{c_k}{c_k} + 3$ N/mm² Whichever is greater</td>
<td>$\geq \frac{c_k}{c_k}^2 N/mm²$</td>
</tr>
<tr>
<td>M 20 Or Above</td>
<td>$\geq \frac{c_k}{c_k} + 0.825 \times$ established standard deviation (rounded off to nearest 0.5 N/mm²)</td>
<td>$\geq \frac{c_k}{c_k}^4 N/mm²$</td>
</tr>
</tbody>
</table>

Note – In the absence of established value of standard deviation, the values give in Table 8 may be assumed, and attempt should be made to obtain results of 30 samples are early as possible to establish the value of standard deviation.

4.2.3.2 Flexural Strength
When both the following conditions are met, the concrete complies with the specified flexural strength.
(a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by the least $0.3$ N/mm².
(b) The strength determined from any test result is not less than the specified characteristic strength less $0.3$ N/mm².

4.3 Inspection and Testing of Structures:
4.3.1 Inspection
To ensure that the construction complies with the design an inspection procedure should be set up covering materials, records, workmanship and construction.

4.3.1.1 Tests should be made on reinforcement and the constituent materials of concrete in accordance with the relevant standards. Where applicable, use should be made of suitable quality assurance schemes.

4.3.1.2 Care should be taken to see that:
(a) Design and detail are capable of being executed to a suitable standard, with due allowance for dimensional tolerances:
(b) There are clear instructions on inspection standards:
(c) There are clear instructions on permissible deviations:
(d) Elements critical to workmanship, structural performance, durability and appearance are identified; and
(e) There is a system to verify that the quality is satisfactory in individual parts of the structure, especially the critical ones.

4.3.2 Immediately after stripping the formwork, all concrete shall be carefully inspected and any defective work or small defects either removed or made good before concrete has thoroughly hardened.

4.3.4 Testing in the case of doubt regarding the grade of concrete used:
In case of doubt regarding the grade of concrete used, either due to poor workmanship or based on results of cube strength tests, compressive strength tests of concrete on the basis of 4.3.5 an/or load test (see 4.3.5.2) may be carried out.

4.3.5 Core Test
4.3.5.1 The points from which cores are to be taken and the number of cores required shall be at the discretion of the engineer-in-charge and shall be representative of the whole of concrete concerned. In no case, however, shall fewer than three cores be tested.

4.3.5.2 Cores shall be prepared and tested as described in IS 516.

4.3.5.3 Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to at least 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75 percent.

4.3.6 In case the core test results do not satisfy the requirements of 4.3.5.3 or where such tests have not been done.

4.4 Steel
4.4.1 The steel used for reinforcement shall be any of the following types:
(a) Mild steel and medium tensile bars conforming to IS 432 (Part 1)
(b) High strength deformed steel bars conforming to IS 1786
(c) Hard drawn steel wire fabric conforming to IS 1566
(d) Structural steel conforming to Grade A of IS 2062
(e) Thermo-mechanically treated (TMT) Bars.

4.4.2 Elongation percent on gauge length is $5.65 \sqrt{A}$ where $A$ is the cross sectional areas of the test Piece.

4.4.2.1 Mild steel is not recommended for the use in structures located in earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

4.4.2.2 Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS 2751.

4.4.3 Nominal mass/weight: The tolerance on mass/ weight for round and square bars shall be the percentage given in Table 4.3 of the mass/ weight calculated on the basis that the masses of the bar/ wire of nominal diameter and of density 7.85 kg/ cm$^3$ or 0.00785 kg/mm$^3$.

<table>
<thead>
<tr>
<th>Nominal size in mm</th>
<th>Tolerance on the Nominal Mass per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Batch</td>
</tr>
<tr>
<td>(a) Upto and including 10</td>
<td>±7</td>
</tr>
<tr>
<td>(b) Over 10, upto and including 16</td>
<td>±5</td>
</tr>
<tr>
<td>(c) Over 16</td>
<td>±3</td>
</tr>
</tbody>
</table>
+ For individual sample plus tolerance is not specified
(x) For coil batch tolerance is not applicable
Tolerance shall be determined in accordance with method given in IS 1786.

4.4.3.1 High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 4.4.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Property</th>
<th>Fe 415</th>
<th>Fe 415 D</th>
<th>Fe 500 D</th>
<th>Fe 500 D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C)</td>
<td>0.2 Per cent Proof stress/ yield stress, Min, N/mm²</td>
<td>415.0</td>
<td>415.0</td>
<td>500.0</td>
<td>550.0</td>
</tr>
<tr>
<td>(ii)</td>
<td>Elongation, per cent, Min, on gauge length 5.65 ( \frac{\sqrt{A}}{2} ) where A is the cross-sectional area of the test piece.</td>
<td>14.5</td>
<td>18.0</td>
<td>16.0</td>
<td>14.5</td>
</tr>
<tr>
<td>(iii)</td>
<td>Tensile strength, Min 10 Percent more than the actual 0.2 per cent proof stress/ yield stress but not less than 485.0 N/mm²</td>
<td>12 Percent more than the actual 0.2 per cent proof stress/ yield stress but not less than 500.0 N/mm²</td>
<td>10 Percent more than the actual 0.2 per cent proof stress/ yield stress but not less than 565.0 N/mm²</td>
<td>8 Per cent more than the actual 0.2 per cent proof stress/yield stress but not less than 600.0 N/mm²</td>
<td></td>
</tr>
<tr>
<td>(iv)</td>
<td>Total elongation at maximum force, percent. Min on gauge length 5.65 ( \frac{\sqrt{A}}{2} ) where A is the cross-sectional area of the test piece.</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Table No. 4.5 LIST OF MANDATORY TESTS

<table>
<thead>
<tr>
<th>Material</th>
<th>Test</th>
<th>Field/laboratory test</th>
<th>Test procedure</th>
<th>Min, quantity of material for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel for Reinforced concrete Tests</td>
<td>(A) Physical and chemical Tests</td>
<td>As per IS 1608 &amp; IS 1786</td>
<td>(a) For consignment below&lt;br&gt;100 tonnes&lt;br&gt;(i) under 10mm dia, one sample for each 25 tonnes or part thereof&lt;br&gt;(ii) 10mm to 16mm dia&lt;br&gt;One sample for each 35 tonnes or part thereof&lt;br&gt;(iii) over 16mm dia one sample for each 45 Tonnes or part thereof</td>
<td>(b) For consignment&lt;br&gt;over 100 tonnes&lt;br&gt;(i) Under 10mm dia, one sample for each 40 tonnes or part thereof&lt;br&gt;(ii) 10mm to 16mm dia&lt;br&gt;One sample for each 45 tonnes or part thereof&lt;br&gt;(iii) over 16mm dia one sample for each 50 tonnes or part thereof</td>
<td></td>
</tr>
</tbody>
</table>
**Tests:** Selection and preparation of Test sample. All the tests pieces shall be selected by the Engineer-in-Charge or his authorized representative either- From cutting of bars or if he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-Charge or his authorized representative and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.-

(a) Tensile Test: 0.2% proof stress and percentage elongation - This shall be done as per IS 1608, read in conjunction with IS 226.
(b) Retest : This shall be done as per IS 1786.
(c) Rebend test: This shall be done as per IS 1786.

4.4.3.2 Chemical composition of reinforcement bars shall be as per Table 4.6 as follows:

<table>
<thead>
<tr>
<th></th>
<th>Maximum Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fe415</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.30</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.060</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.060</td>
</tr>
<tr>
<td>Sulphur and Phosphorus</td>
<td>0.110</td>
</tr>
</tbody>
</table>

4.4.3.3 Thermo Mechanically treated reinforcement bars: (TMT bars)
(a) The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.
(b) The TMT bars are being produced under valid license from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench.
(c) The TMT bars shall conform to IS 1786 pertaining to Fe 415 D or Fe 500 D or Fe grade of steel as specified.
(d) In design and construction of reinforced concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermo mechanical treatment process of grade Fe 415, Fe 500 and Fe 550 having elongation more than 14.5% and conform to other requirements of Fe 415 D, Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

4.4.4 Stacking and Storage
Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different classifications, sizes and lengths shall be stored separately by giving color code facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

4.5 FORM WORK (CENTRING & SHUTTERING)
4.5.1 General
The formwork shall be designed and constructed so as to remain sufficiently rigid during placing and compaction of concrete, and shall be such as to prevent loss of slurry from the concrete. For further details regarding design, detailing, etc, reference may be made to IS 14687. The tolerances on the shapes, lines and dimensions shown in the drawing shall be within the limits given below.

4.5.2 Design & Tolerance in Construction
Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance given below.
(a) Deviation from specified dimension of cross section of columns and beams +12 mm -6 mm
(b) Deviation from dimensions of footings
(i) Dimension in Plan

\[+50 \text{ mm}\]

\[-12\text{ mm}\]

(ii) Eccentricity in plan

\[0.02 \times \text{the width of the footing in the direction of deviation but not more than 50 mm.}\]

(iii) Thickness

\[\pm 0.05 \times \text{the specified thickness.}\]

(Note- These tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels).

4.5.3 General Requirement
Form work shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

4.5.3.1 Material for Form Work
(a) Propping and Centering: All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

4.5.3.2 (a) Centering/Staging : Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made form rolled structural steel sections.

(b) in case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

(c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

4.5.3.3 Shuttering: Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. Steel shuttering before use should be sufficiently stiffened, properly repaired and cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

(a) Runner Joists: RSJ, MS Channel or any other suitable section of the required size shall be used as runners.

(b) Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.

(c) Only steel shuttering shall be used, except for unavoidable portions and very small works for which 12 mm thick water proofing ply of approved quality may be used.

4.5.3.4 Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process. In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages.

4.5.3.5 Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250 ) and for cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

4.5.3.6 Walls: The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs, etc.

4.5.3.7 Removal of Form work (Stripping Time) : In normal circumstance and where various types of cements are used, forms, may generally be removed after the expiry of the following periods;
<table>
<thead>
<tr>
<th>Type of Form work</th>
<th>Minimum period Before Striking Form work for OPC 33 grade</th>
<th>Minimum period Before Striking Form work for OPC 43 grade</th>
<th>Minimum period Before Striking Form work for PPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Vertical form work to columns, walls, beams</td>
<td>16-24h</td>
<td>16-24 h</td>
<td>24-36 h</td>
</tr>
<tr>
<td>(b) Soffit form work to slabs (Props to be refixed immediately after removal of formwork)</td>
<td>3 days</td>
<td>3 days</td>
<td>4 days</td>
</tr>
<tr>
<td>(c) Soffit form work to beams (Props to be refixed immediately after removal of formwork)</td>
<td>7 days</td>
<td>7 days</td>
<td>10 days</td>
</tr>
<tr>
<td>(d) Props to slabs;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Spanning upto 4.5m</td>
<td>7 days</td>
<td>7 days</td>
<td>10 days</td>
</tr>
<tr>
<td>(2) Spanning over 4.5m</td>
<td>14 days</td>
<td>14 days</td>
<td>20 days</td>
</tr>
<tr>
<td>(e) Props to beams and arches:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Spanning upto 6m</td>
<td>14 days</td>
<td>14 days</td>
<td>20 days</td>
</tr>
<tr>
<td>(2) Spanning over 6m</td>
<td>21 days</td>
<td>21 days</td>
<td>30 days</td>
</tr>
</tbody>
</table>

**Note :-**
(a) For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally if Portland pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.
(b) The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.
(c) For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.
(d) In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.
(e) Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.
(f) Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

### 4.5.4 Surface Treatment

#### 4.5.4.1 Oiling the Surface:
Shuttering gives much longer service life if the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections.

Typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in cases when shuttering has been stored for a long time, it should be recoated with mould oil before the next use.

The second categories of shuttering oils / leavening agents are Polymer based water soluble Compounds. They are available as concentrates and when used diluted with water in the ratio of 1:20 or as per manufacturer specifications. The diluted solution is applied by brush applications on the shuttering both of steel as well as ply wood. The solution is applied after every use.

#### 4.5.4.2 The design of form work shall conform to sound Engineering practices and relevant IS codes.
4.5.5 Inspection of Form Work
The completed form work shall be inspected and approved by the Engineer-in-Charge before the reinforcement bars are placed in position.
(a) Proper form work should be adopted for concreting so as to avoid honey combs, blow holes, grout loss, stains or discoloration of concrete etc.
(b) Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by Engineer-in-Charge.
(c) Shuttering surface before concreting should be free from any defect/ deposits and full cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

4.5.5.1 Erection of Form Work (Centering and shuttering): Following points shall be borne in mind while checking during erection.
(i) Any member which is to remain in position after the general dismantling is done, should be clearly marked.
(ii) Material used should be checked to ensure that, wrong items/ rejects are not used.
(iii) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
(iv-a) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
(iv-b) Sole plates shall be properly seated on their bearing pads or sleepers.
(iv-c) The bearing plates of steel props shall not be distorted.
(iv-d) The steel parts on the bearing members shall have adequate bearing areas.
(v) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.
(vi) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.
(vii) The stacked materials shall be placed as catered for, in the design.
(viii) When adjustable steel props are used. They should:
   a) be undamaged and not visibly bent.
   b) Have the steel pins provided by the manufacturers for use.
   c) Be restrained laterally near each end.
   d) Have means for centralizing beams placed in the fork heads.
(ix) Screw adjustment of adjustable props shall not be over extended.
(x) Doubled wedges shall be provided for adjustment of the form to the required position wherever any settlement/ elastic shorting of props occur. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/clamped down after adjustment to prevent shifting.
(xi) No member shall be eccentric upon vertical member.
(xii) The number of nuts and bolts shall be adequate.
(xiii) All provisions of the design and/or drawings shall be complied with.
(xiv) Cantilever supports shall be adequate.
(xv) Props shall be directly under one another in multistage constructions as far as possible.
(xvi) Guy ropes or stays shall be tensioned properly.
(xvii) There shall be adequate provision for the movements and operation of vibrators and other construction plant and equipment.
   (xviii) Required camber shall be provided over long spans.
(xix) Supports shall be adequate, and in plumb within the specified tolerances.
4.5.6 Measurements

4.5.6.1 General: The form work shall include the following:
(a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
(b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
(c) Bolts, wire, ties, clamps, spreaders, nails or any other items to hold the sheathing together.
(d) Working scaffolds, ladders, gangways, and similar items.
(e) Filleting to form stop chamfered edges of splayed external angles not exceeding 20mm wide to beams, columns and the like.
(f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.
(g) Dressing with oil to prevent adhesion.
(h) Raking or circular cutting.

4.5.6.2 Classification of Measurements: Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following:

(a) Foundations, footings, bases of columns etc. and for mass concrete.
(b) Waifs (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
(c) Suspended floors, roofs, landings, shelves and their supports and balconies.
(d) Lintels, beams, plinth beams, girders, bressummers and cantilevers.
(e) Columns, pillars, piers, abutments posts and struts.
(f) Stairs (excluding landings) except spiral staircase.
(g) Spiral staircases (including landings).
(h) Arches, Domes, vaults, shells roofs, arch ribs, curvilinear shaped folded plates.
(i) Extra for arches, domes, vaults exceeding 6 m span other than curvilinear shaped.
(j) Chimneys and shafts.
(k) Well steining.
(l) Vertical and horizontal fins individually or forming box, louvers and bands. facias and eaves board.
(m) Waffle or ribbed slabs.
(n) Edges of slabs and breaks in floors and walls (to be measured in running meters where below 200 mm in width or thickness).
(o) Cornices and mouldings.
(p) Small surfaces, such as cantilevers ends, brackets and ends of steps, caps and boxes to pilasters and columns and the like.
(q) Chullah hoods, weather shades, chajjas, corbels etc. including edges and
(r) Elevated water reservoirs.

4.5.6.3 Centering, and shuttering where exceeding 3.5 meter height in one floor shall be measured and paid for separately.

4.5.6.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

4.5.6.5 No deductions from the shuttering due to the openings/ obstructions shall be made if the area of each openings/ obstructions does not exceed 0.4 square meters. Nothing extra shall be paid for forming such openings.

4.5.6.6 Form work of elements measured under categories of arches, arch ribs, domes, spiral staircases, well steining, shell roofs, curvilinear folded plates & curvilinear eaves board, circular shafts & chimneys shall not qualify for extra rate for circular work.

4.5.6.7 Extra for circular work shall be admissible for surfaces circular or curvilinear in plan or in elevation beyond the straight edge of supporting beam in respective mode of measurement. However,
there may be many different types of such structures. In such cases, extra payment shall be made judiciously after deducting areas where shuttering for circular form work is not involved.

4.5.7 Rate
The rate of the form work includes the cost of Labour and materials required for all the operations described above.

4.6 REINFORCEMENTS
4.6.1 General Requirements
Steel conforming to Para 4.1.3 for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coating which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

4.6.1.1 Assembly of Reinforcement: Bars used of full length shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer-in-Charge. Necessary cutting and straightening, Overlapping of bars, where necessary shall be done as directed by the Engineer-in-charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or 1¼ times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.

4.6.1.2 Bonds and Hooks Forming End Anchorages: Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

(a) U-Type Hook
In case of mild steel plain bars standard U type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter equal to four times the diameter of the bar.

Note: In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawings.

(b) Bends
Bend forming anchorage to a M.S. plain bar shall be bent with and internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

4.6.1.3 Anchoring Bars in Tension: Deformed bars may be used without end anchorages provided, development length equipment is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per IS: 456.

4.6.1.4 Anchoring Bars in Compression: The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of hooks, bend and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

4.6.1.5 Binders, stirrups, links etc. : In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times and nominal size of bar.

4.6.2 Welding of Bars
Wherever facility for electric arc welding or gas pressure welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-Charge. Welding shall be as per IS 2751 and 9417.

4.6.3 Placing in Position
4.6.3.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.
Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-Charge.

4.6.3.2 The bars shall be kept in correct position by the following methods:
(a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1 cement: 2 coarse sand) about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.
(b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 meter or at shorter spacing to avoid sagging.
(c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them or with clock of cement mortar 1:2 (1 cement: 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.
(d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

4.6.3.3 Tolerance on Placing of Reinforcement: Unless otherwise specified by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances:

<table>
<thead>
<tr>
<th>Tolerance in spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) For effective depth, 200 mm or less</td>
</tr>
<tr>
<td>(b) For effective depth, more than 200 mm</td>
</tr>
</tbody>
</table>

4.6.3.4 Bending at Construction Joints: Where reinforcement bars are bent aside at construction Joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameter for deformed bars. Care should also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

4.6.3.5 Cover: The minimum nominal cover to meet durability requirements shall be as under-

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Nominal Concrete cover in mm not less than</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>20</td>
</tr>
<tr>
<td>Moderate</td>
<td>30</td>
</tr>
<tr>
<td>Severe</td>
<td>45</td>
</tr>
<tr>
<td>Very severe</td>
<td>50</td>
</tr>
<tr>
<td>Extreme</td>
<td>75</td>
</tr>
</tbody>
</table>

Notes:
1. For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by +10 mm.
3. For exposure condition ‘severe’ and ‘very severe’ reduction of 5 mm may be made, where concrete grade is M35 and above.
4. Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 1GA of IS 456.

4.6.4 Measurement
Reinforcement including authorized spacer bars and lap pages shall be measured in length of different diameter, as actually (not more than as specified in the drgs.) used in the work nearest to a centimeter and their weight calculated on the basis of standard weight given in Table 4.7 below. In case actual unit weight of the bars is less than standard unit weight, but within variation, in such cases weight of reinforcement shall be calculated on the basis of actual unit weight. Wastage and unauthorized overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement.
Where tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the Engineer-in-Charge and measured separately and paid for.

### TABLE 4.7 Cross Sections Area and Mass of Steel Bar

<table>
<thead>
<tr>
<th>Nominal Size mm</th>
<th>Cross sectional Area Sq.mm</th>
<th>Mass per meter Run Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>28.3</td>
<td>0.222</td>
</tr>
<tr>
<td>8</td>
<td>50.3</td>
<td>0.395</td>
</tr>
<tr>
<td>10</td>
<td>78.6</td>
<td>0.617</td>
</tr>
<tr>
<td>12</td>
<td>113.1</td>
<td>0.888</td>
</tr>
<tr>
<td>16</td>
<td>201.2</td>
<td>1.58</td>
</tr>
<tr>
<td>20</td>
<td>314.3</td>
<td>2.47</td>
</tr>
<tr>
<td>25</td>
<td>491.1</td>
<td>3.85</td>
</tr>
<tr>
<td>28</td>
<td>615.8</td>
<td>4.83</td>
</tr>
<tr>
<td>32</td>
<td>804.6</td>
<td>6.31</td>
</tr>
<tr>
<td>36</td>
<td>1018.3</td>
<td>7.99</td>
</tr>
<tr>
<td>40</td>
<td>1257.2</td>
<td>9.86</td>
</tr>
</tbody>
</table>

**Note:** These are as per clause 6.2 of IS 1786.

### 4.6.5 Rate

The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, hooking bending, binding, placing in position etc. as required or directed including tack welding on crossing of bars in lieu of binding with wires.

### 4.7 CONCRETING

The concrete shall be as specified under chapter 3 concrete work. The proportion by volume or by the weight of ingredients shall be as specified.

#### 4.7.1 Consistency

The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated on or hand tamped, it shall be determined by slump test as prescribed in sub-head “concrete” under workability - requirement.

#### 4.7.2 Placing of Concrete

**4.7.2.1** Concreting shall be commenced only after Engineer-in-Charge has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shavings, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed in 4.5.4.

**4.7.2.2** In case of concreting of slab and beams, wooden plank or cat walks of chequered MS plated or bamboo chalies or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.

**4.7.2.3** In case of columns and wall, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction, shall be restricted to one meter per hour.

**4.7.2.4** The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the Engineer-in-Charge. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 meters at a time.

**4.7.2.5** During cold weather, concreting shall not be done when the temperature falls below 4.5°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.
During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

Compaction

It shall be as specified in sub-head of Concrete Work of this specification.

Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations complying with IS 2505, IS 2506, IS 2514 and IS 4656. The Engineer-in-Charge may however relax this condition at his discretion for certain items depending on the thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation; such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.

Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibration. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. within 30 minutes of addition of water to the dry mixture.

Construction joints

Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown in structural drawing or as directed by Engineer-in-Charge. Number of such joints shall be kept to minimum. The joints shall be kept at places where the shear force is the minimum. These shall be straight and shall be at right angles to the direction of main reinforcement. Construction Joints should comply with IS 11817.

In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.

When stopping the concrete on a vertical plane in slabs and beams and approved stop board shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.

When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square meter shall then be applied on the roughened surface before fresh concrete is laid.

Expansion Joints

Expansion joints shall be provided as shown in the structural drawings or as directed by Engineer-in-Charge, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these Joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in
running meter. The measurement shall be taken two places of decimal stating the depth and width of joint.

4.7.6 Curing
After the concrete has begin to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the Engineer-in-Charge. After 24 hours of laying of concrete, the surface shall be cured by pounding with water for a minimum period of 7 days from the date of placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather condition.

4.7.7 Finishing
4.7.7.1 In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set. Sprinkling of dry cement while finishing shall not be resorted to.

4.7.7.2 Immediately on removal of forms, the R.C.C. work shall be examined by the Engineer-in-Charge, before any defects are made good.
(a) The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given in para 4.7.9.4 for visual inspection test.

(b) Surface defects of minor nature may be accepted. On acceptance of such a work by the Engineer-in-Charge, the same shall be rectified as follows:

1. Surface defects which require repair when forms are removed, usually consist of bulged due to movement of forms, ridges at form joints, honey-combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly under cut to provide a key at the edge of the patch.

2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.

3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.

4. Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.

5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.

6. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.

7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.

(c) The exposed surface of R.C.C. work shall be plastered with cement mortar 1:3 (1 cement: 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. Any RCC surface which remains permanently exposed to view in the completed structure shall be considered exposed surfaces for the purpose of this specification. Where such exposed surface
exceeding 0.5 sqm in each location is not plastered with cement mortar 1:3 (1 cement: 3 fine sand) 6 mm thick, necessary deduction shall be made for plastering not done.

(d) The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster. RCC work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6 mm.

(e) The surface of RCC slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

4.9.9 Testing of Concrete
Regular mandatory tests on the workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types
(a) Mandatory Lab. Test
(b) Mandatory Field Test
Results of Mandatory Field Test will prevail over mandatory Lab. Test.

4.9.9.1 Cube Test for Compressive Strength of Concrete - Mandatory Lab Test:
Mandatory tests shall be:-
One sample (consisting of six cubes 15x15x15 cm shall be taken for every 20 cum or part thereof concrete work ignoring any part less than 5cum or as often as considered necessary by the Engineer-in-Charge. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site in the Performa as below:-

<table>
<thead>
<tr>
<th>REGISTER OF WORK TEST FOR CONCRETE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Name of work</td>
</tr>
<tr>
<td>(b) Name of Contractor</td>
</tr>
<tr>
<td>(c) Agreement No.</td>
</tr>
<tr>
<td>(d) Sample No.</td>
</tr>
<tr>
<td>(e) Identification mark</td>
</tr>
<tr>
<td>(f) Portion of work any quantity represented by sample</td>
</tr>
<tr>
<td>(g) Date and time of casting cube</td>
</tr>
<tr>
<td>(h) Proportion of mix/ grade of concrete</td>
</tr>
</tbody>
</table>

The casting of cubes, concrete used for cubes and all other incidental charge, such are curing, carriage to the testing laboratory shall be borne by the contractors. The testing fee for the cubes, if any, shall be borne by the department.

A-1 Test Procedure - Chapter 4

B-1 REBOUND HAMMER TEST
If a rebound hammer is regularly used by trained personnel in accordance with procedure described in IS 13311 (part II) and a continuously maintained individual charts are kept showing a large number of reading and the relation between the reading and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure for element. If calibration charts are available from manufactures, it can be used. When making rebound hammer test each result should be the average of at least 12 readings. Reading should not be taken within 20mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a trowled face and those on a moulded face. When making the tests on a precast unit, special care should be taken to bed them firmly against the impact of the hammer.
B-2 CUTTING CORES
This method involves drilling and testing cores from the concrete for determination of compressive
strength, in suitable circumstances, the compressive strength of the concrete in the structure may be
assessed by drilling cores from the concrete and testing. The procedure used shall comply with the
requirements of IS 1199 and IS 516.

The points from which cores shall be taken shall be representative of the whole concrete and at least
three cores shall be obtained and tested. If the average of the strength of all cores cut from the
structure is less than the specified strength, the concrete represented by the cores shall be liable to
rejection and shall be rejected if a static load test (B-5) either cannot be carried out or is not permitted
by the Engineer-in-Charge.

B-3 ULTRASONIC TEST
If an ultrasonic apparatus is regularly used by trained personnel in accordance with IS 13311 (part I)
and continuously maintained individual charts are kept showing a large number of readings & the
relation between the reading and strength of cubes made from the same batch of concrete, such charts
may be used to obtain approximate indications of the strength of concrete in the structures. In cases of
suspected lack of compaction or tow cube strength the results obtained from the ultrasonic test results
on adjacent acceptable section of the structures may be used for the purpose of assessing the strength
of concrete in the suspected portion.

B-4 LOAD TESTS ON INDIVIDUAL PRECAST UNITS
The load tests described in this clause are intended as check on the quality of the units and should not
be used as substitute for normal design procedure. Where members require special testing. Such
special testing procedures shall be in a accordance with the specification. Test loads shall be applied
and removed incrementally.

B-4.1 Non Destructive Tests
The unit shall be supported at its designed point of support and loaded for five minutes with a load
equal to the sum of the characteristic dead load plus one and a quarter time the characteristic imposed
load. The deflection is then recorded. The maximum deflection after application of the load shall be in
accordance with the requirements defined by the Engineer-in-Charge. The recovery is measured five
minutes after the removal of the load and the load then reimposed. The percentage recovery after the
second loading shall be not less than that after the first loading nor less than 90% of the deflection
recorded during the second loading. At no time during the tests, shall the unit show any sign of
weakness or faulty construction as defined by the Engineer-in-Charge in the light of reasonable
interpretation of relevant data.

B-4.2 Destructive Tests
The unit is loaded while supported at its design point of support and must not fall at its design load for
collapse, within 15 minutes of time when the test load becomes operative. A deflection exceeding 1/40
of the test span is regarded as failure of the unit.

B-4.3 Special Tests
For very large units or units not readily amenable to the above test i.e. columns, the precast parts of
composite beams and members designed for continuity or fixity, the testing arrangements shall be
agreed upon before such units are cast.

B-5 Load Test of Structures or Parts of Structures
The test described in this clause are intended as a check where there is a doubt regarding structural
strength. Test loads are to be applied and removed incrementally.

B-5.1 Age at Tests
The test is to be carried as soon as possible after the expiry of 28 days from the time of placing of the
concrete. When the test is for a reason other than the quality of concrete in the structure being in doubt,
the test may be carried out earlier, provided that the concrete has already reached its specified
characteristic strength.

B-5.2 Test Load
The test loads to be applied for the limit state of deflection and local damage are the appropriate design
loads i.e, the characteristic dead and superimposed loads. When the limit state of collapse is being
considered the test load shall be equal to the sum of characteristic dead load plus one and a quarter times the characteristic imposed load and shall be maintained or a period of 24 hours. In any of the test temporary supports of sufficient strength to take the whole load shall be placed in position underneath but not in contact with the members being tested. Sufficient precautions must be taken to safeguard persons in the vicinity of the structure.

B-5.3 Measurement During Tests
Measurements of deflection and crack width shall be taken immediately after applications of the load and, in the case of 24 hour sustained load test, at the end of 24 hour loaded period, after removal of the load and after 24 hour recovery period. Sufficient measurements shall be taken to enable side effect to be taken in account. Temperature and weather conditions shall be recorded during the tests.

B-5.4 Assessment of Results
In assessing the strength of a structure or a part of the structure following a loading test, the possible effects of variation in temperature and humidity during the period of the test shall be considered.

The following requirements shall be met:
(a) The maximum width of any crack measured immediately on application of the test load for local damage, is to be not more than 2/3 of the value of the appropriate limit state requirement.

(b) For members spanning between two supports the deflection measured immediately on application of the test load for deflection is to be not more than 1/500 of the effective span limits shall be agreed upon before testing cantilevered portions of structure.

(c) If maximum deflection in mm shown during 24 hour under load is less than $40L^2/D$ where $L$ is effective span in mm and $D$ is overall depth of construction in mm, it is not necessary for the recovery to be measured and the requirement (D) does not apply, and

(d) If within 24 hours of the removal of test load for collapse as calculated in clause (a) a reinforced concrete structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 hour under load, the loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after second loading is not at least 75 per cent of the maximum deflection shown during the second loading.

B-6 DETERMINATION OF WATER SOLUBLE AND ACID SOLUBLE CHLORIDES IN CONCRETE
Determination of water soluble and acid soluble chlorides in Concrete shall be done as per method of test given in IS 14959 (Part 1) which covers volumetric method of test as described below:

4.7.9.4 Visual Inspection Test: The concrete will be inspected after removal of the form work. The question of carrying out mandatory test or other tests described as above:-

The concrete is liable to be rejected if:
(i) It is porous or honeycombed as per Para 4.4.7.2 (a) above.
(ii) Its placing has been interrupted without providing a proper construction joint.
(iii) The reinforcement has been displaced beyond tolerance specified or construction tolerances have not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge at the risk and cost of the contractor.

4.7.10 Standard of Acceptance - for Nominal Mix
4.7.10.1 Mandatory Lab. Test: For concrete sampled and tested as prescribed above. The following requirement shall apply.

4.7.10.2 Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days.
Register of 7 Day’s test shall be prepared as given below Part-A & B

<table>
<thead>
<tr>
<th>Part-A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Name of work</td>
<td>Concrete mix, (by volume)</td>
</tr>
<tr>
<td>(b) Name of Contractor</td>
<td></td>
</tr>
<tr>
<td>(c) Agreement No.</td>
<td></td>
</tr>
<tr>
<td>(d) Sample No.</td>
<td></td>
</tr>
<tr>
<td>(e) Identification mark</td>
<td></td>
</tr>
<tr>
<td>(f) Portion of work any quantity represented by sample</td>
<td></td>
</tr>
<tr>
<td>(g) Date and time of casting cube</td>
<td></td>
</tr>
<tr>
<td>(h) Proportion of mix/grade of concrete.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part-B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Due date of test</td>
<td>Cube No.</td>
</tr>
<tr>
<td>(2) Actual date of test</td>
<td></td>
</tr>
<tr>
<td>(3) (a) Minimum strength</td>
<td></td>
</tr>
<tr>
<td>(b) Maximum strength</td>
<td></td>
</tr>
<tr>
<td>(c) Average strength of three cubes</td>
<td></td>
</tr>
<tr>
<td>(d) Difference between 3a and 3b</td>
<td></td>
</tr>
<tr>
<td>(e) Difference in % age in terms of average strength i.e. 3b-3a x100 3c</td>
<td></td>
</tr>
<tr>
<td>(4) Specified compressive strength of concrete mix used</td>
<td></td>
</tr>
<tr>
<td>(5) (a) If 3(e) is more than 30%</td>
<td>Sample is not acceptable, then 28 days strength test shall be carried out.</td>
</tr>
<tr>
<td>(b) If 3(e) is equal to or less than 30% then proceed as below: -</td>
<td></td>
</tr>
<tr>
<td>(i) Difference between column 4 specified compressive strength and column 3 (c) i.e., actual average is higher, it will be denoted (+) and (-) if it is less.</td>
<td></td>
</tr>
<tr>
<td>(ii) Difference in column 5(b) (i) terms of % age of specified strength</td>
<td>3(c) - (4c)x100% 4</td>
</tr>
<tr>
<td>(iii) If the difference in column 5(b) (i) is +ve and the same in terms of % age of specified strength (4) i.e., value of col. 5(b) (ii) is within (+15% range)</td>
<td>Acceptable &amp; strength is considered in order</td>
</tr>
</tbody>
</table>

Para 4.10.3 - 7 days Test

**Sampling:** The average of the strength of three specimen shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than ±15% of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimen; If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days’ test shall have to be carried out.

**Strength:** If the actual average strength of sample accepted in para ‘sampling’ above is equal to or higher than specified strength upto ±15% then strength of the concrete shall be considered in order;

In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days’ test shall have to be carried out to determine the compressive strength of concrete cubes.
Register of 28 Day’s test shall be prepared as given below Part-A & B

<table>
<thead>
<tr>
<th>Part-A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Name of work</td>
<td>Concrete mix, (by volume)</td>
</tr>
<tr>
<td>(b) Name of Contractor</td>
<td></td>
</tr>
<tr>
<td>(c) Agreement No.</td>
<td></td>
</tr>
<tr>
<td>(d) Sample No.</td>
<td></td>
</tr>
<tr>
<td>(e) Identification mark</td>
<td></td>
</tr>
<tr>
<td>(f) Portion of work any quantity represented by sample</td>
<td></td>
</tr>
<tr>
<td>(g) Date and time of casting cube</td>
<td></td>
</tr>
<tr>
<td>(h) Proportion of mix/grade of concrete.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part-B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Due date of test</td>
<td>Cube No.</td>
</tr>
<tr>
<td>(2) Actual date of test</td>
<td></td>
</tr>
<tr>
<td>(3) Actual compressive strength of cubes (min. no. of cubes to be tested -three)</td>
<td></td>
</tr>
<tr>
<td>(a) Minimum strength</td>
<td></td>
</tr>
<tr>
<td>(b) Maximum strength</td>
<td></td>
</tr>
<tr>
<td>(c) Average strength of three cubes</td>
<td></td>
</tr>
<tr>
<td>(d) Specified compressive strength of concrete</td>
<td></td>
</tr>
<tr>
<td>(e) 70% specified strength</td>
<td>i.e. 70% of 3(d)</td>
</tr>
<tr>
<td>(f) 130% of specified strength</td>
<td>i.e. 130% of 3(d)</td>
</tr>
<tr>
<td>(4) If 3(b) = 3(f) and 3(a) ≥ 3(e)</td>
<td>Value of 3(c) shall be compressive strength of sample</td>
</tr>
<tr>
<td>(5) If 3 (c) is more than 3(f)</td>
<td>EE may order further investigation</td>
</tr>
<tr>
<td>(6) If any test value exceeds 3(f)</td>
<td>It should be restricted to 3(f) for computation of strength</td>
</tr>
<tr>
<td>(7) If 3 (c) ≥ 3(d) but&lt;3(f)</td>
<td>Strength is in order and concrete accepted at full rates.</td>
</tr>
<tr>
<td>(8) If 3 (c) &lt; 3(d) and &gt; 3(e)</td>
<td>Concrete may be accepted at reduced rates in accordance with para 4.7.13.2</td>
</tr>
<tr>
<td>(9) If 3 (c) &lt; 3(e)</td>
<td>Work represented by this sample shall be rejected and action taken as prescribed in clause 4.7.10.4</td>
</tr>
</tbody>
</table>

Para 4.10.4 - 28 days Test
(a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30% the Engineer-in-Charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30%-of specified strength, it will be restricted to 130% only for computation of strength.

(c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge. (See para 4.7.13.2)

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the
risk and cost of contractor. If, however the Engineer-in-Charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

4.7.10.5 Acceptance Criteria of Field Test (Additional Test- Not Mandatory)

(A) Preservation of Cubes at site

Standard sample cubes cast shall be carefully preserved at site under the safe custody of AE or his representative for making them available together with the charts, to the officers of QCTA/CTE or any other senior departmental officer, during their inspection of the work. They will calibrate their hammer on these cubes if required.

4.7.11 Measurements

4.7.11.1 Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm. The areas shall be worked out nearest to 0.01 Sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic meters.

4.7.11.2 Reinforced cement concrete whether cast-in-situ or pre cast shall be classified and measured separately as follows.

(a) Raft, footing, bases of columns and mass concrete etc. all work up to plinth level/column up to plinth level, plinth beams.
(b) Wall (any thickness) including attached pilasters, buttresses plinth and string course, fillets, column, pillars, piers, abutments, post and struts etc.
(c) Suspended floors, roofs, landings and balconies.
(d) Shelves
(e) Chajjas
(f) Lintel, beams and bressummers.
(g) Columns, pillars, piers, abutments, posts and struts.
(h) Stair-cases including waist or waist less slab but excluding landing except in (i) below.
(i) Spiral stair-case (including landing).
(j) Arches, arch ribs, domes and vaults.
(k) Chimneys and shafts.
(l) Well steining.
(m) Vertical and horizontal fins individually or forming box, louvers and facias.
(n) Kerbs, steps and the like.
(o) String courses, bands, coping, bed plates, anchor blocks, plain window sills and the like.
(p) Mouldings as in cornices, window sills etc.
(q) Shell, dome and folded plates.
(r) Extra for shuttering in circular work in plan.

4.7.11.3 Work under the following categories shall be measured separately.

(a) Rafts, footings, bases of columns etc. and mass concrete.
(b) All other items upto floor two level.
(c) From floor two level to floor three level and so on.
(d) R.C.C. above roof level shall be measured along with R.C.C. Work in floor just below.

4.7.11.4 No deduction shall be made for the following:

(a) Ends of dissimilar materials (e.g. Joists, beams, post, griders, rafter, purlins, trusses, corbels steps etc.) upto 500 sq cm in cross-section.
(b) Opening upto 0.1 sqm.
   Note: In calculating area of openings upto 0.1 sqm the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for.
(c) The volume occupied by reinforcement.
(d) The volume occupied by water pipes, conduits etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

4.7.11.5 Measurement shall be taken before any rendering is done in concrete members. Measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

(a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face to face of the beam.
(b) Beams shall be measured from face to face of columns and shall be including haunches, if any, between columns and beam. The depth of the beam shall be from the bottom of slab to the bottom of beam if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of beam shall be from the top of the slab to the bottom of beam.

(c) The columns measurements shall be taken through.

(d) Chajjas along with its bearing on wall shall be measured in cubic meter nearest to two places of decimal. When chajjas is combined with lintel, slab or beam, the projecting portion shall be measured as chajjas, built in bearing shall be measured as per item of lintel, slab or beam in which chajja bears.

(e) Where the band and lintels are of the same height and the band serves as lintel the portion of the band to be measured as lintel shall be for clear length of opening plus twice the over all depth of band.

4.7.12 Tolerances
Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C. members shall be as specified in the drawings by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the Engineer-in-Charge after consultations with the Designer, if necessary.

When tolerances in dimensions are permitted, following procedure for measurement shall apply.

(a) If the actual dimension of R.C.C. members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurement.

(b) If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.

(c) If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.

(d) For acceptance of RCC members whose dimensions are not exactly as per design dimensions, the decision of Engineer-in-Charge shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply.

4.7.13 Rate
4.7.13.1 The rate included the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering.

4.7.13.2 On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but up to 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to specified compressive strength.

4.8 ENCASING ROLLED STEEL SECTIONS
4.8.1 General Requirements
Before concrete work is started, the Engineer-in-Charge shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust/ scales etc. Where so specified, ungalvanised metal, having mesh or perforations large enough to permit the free passage of 12.5 mm nominal size aggregate through them shall be wrapped round the section to be encased and paid for separately.

4.8.2 Wrapping
4.8.2.1 In case of columns, the wrapping shall be arranged as to pass through the centre of the concrete covering. The wrapping of the entire length of the columns be carried out in stages and no stage shall cover more than 1.5 meter of height of columns.

Successive wrappings shall be carried out only after the immediate adjacent wrapping has been encased in concrete. The surface and edges of the flanges of the steel columns shall have a concrete cover of not less than 50mm. The wrappings of the successive stages shall be tied together.
4.8.2.2 In the case of beams and grillages the wire mesh or expanded metal shall be wrapped round
the lower flange of the beam as and the wrapping shall be suspended by wire hangers 5 mm diameter
placed at about 1.2 meters centers.

The surfaces and edges of the steel sections shall have a concrete cover of not less than 50mm. The
wrapping shall pass through the centre of the concrete covering at the edges and soffits of the flanges.

4.8.3 Form Work shall be as prescribed in 4.2.

4.8.4 Concreting
Concrete shall consist of a mix of 1:2:4 (1 cement; 2 coarse and : 4 graded stone aggregate of 12.5 mm
nominal size) unless a richer mix is specified. The mix shall be poured solidly around the steel sections
and around the wrapping by vibrating the concrete into position. Consistency of concrete, Placing of
concrete and its compaction, curing, finishing and strength of concrete shall be as described in 4.10.4.

4.8.5 Measurements
The length shall be measured correct to one cm and other dimensions correct of 0.5 cm. The cement
concrete shall be measured as per gross dimensions of the encasing exclusive of the thickness of
plaster. No deduction shall be made for the volume of steel sections, expanded metal, mesh or any
other reinforcement used therein. However, in case of boxed stanchions or girders, the boxed portion
only shall be deducted. Fabric reinforcement such as expanded metal shall be measured separately in
square meters stating the mesh and size of strands. The description shall include the bending of the
fabric as necessary, Racking or circular cutting and waste shall be included in the description.

4.8.6 Rate
The rate shall include the cost of materials and labour required for all the operations described above
except the cost of fabric reinforcement. The cost of providing and erecting steel section and wire
hangers shall be paid for separately.

4.9 PRECAST REINFORCED CONCRETE
4.9.1 General Requirements
1. Precast reinforced concrete units such as columns, fencing posts, door and window frames,
lintels, chajjas, copings, sills, shelves, slabs, louvers etc. shall be of grade of mix as specified
and cast in forms or moulds.
2. The forms/ moulds shall be of fiber glass or of steel sections for better finish.
3. Provision shall be made in the forms and moulds to accommodate fixing devices such as nibs,
clips, hooks, bolts and forming of notches and holes.
4. The contractor may precast the units on cement or steel platform which shall be adequately
oiled provided the surface finish is of the same standard as obtained in form. Each unit shall be
cast in one operation.
5. Concrete used for precasting the units should be well proportioned, mixed, placed and
thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and
honey combing.
6. Precast articles shall have a dense surface finish showing no coarse aggregate and shall have
no cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other
defects that would interfere with the proper placing of the units.
7. All angle of the precast units with the exception of the angles resulting from the splayed or
chamfered faces shall be true right angles.
8. The arises shall be clean and sharp except those specified or shown to be rounded. The
wearing surface shall be true to the lines.
9. On being fractured, the interior of the units should present a clean homogeneous appearance.
10. The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of
the main bar, whichever is more, unless otherwise directed in respect of all items except
fencing posts or electric posts where the minimum cover shall be 25 mm.
Curing of precast reinforced concrete

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of casting.

1. The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled.

2. Marking: Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

3. Precast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged.

**4.10 PRECAST CEMENT CONCRETE JALI**

4.10.0 The jali shall be of cement concrete 1:2:4 (1 cement 2 coarse sand:4 stone aggregate 6 mm nominal size) reinforced with 1.6 mm thick mild steel wire, unless otherwise specified.

**4.10.1 Fixing**

The jali shall be set in position true to plumb and level before the Joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

**4.10.2 Measurements**

The jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

**4.10.3 Rate**

The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under relevant items of plastering.

**4.11 DESIGN MIX CONCRETE**

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The minimum mix of M25 shall be used in all structural elements in both load bearing & RCC framed construction.

**4.11.1 Concrete Mix Design and Proportioning**

(i) Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcement and completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

(ii) Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.

(iii) As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23. Reference may also be made to ACI 211.1-77 for guidance.

(iv) Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer-in-Charge.

(v) All concrete proportions for various grades of concrete shall be designed separately. The mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

(vi) Prior to use an admixture in concrete, its performance shall be evaluated by comparing the properties of concrete with the admixture and concrete without any admixture. Chloride content of admixture should be declared by the manufacturer of admixture and shall be within limits stipulated by IS: 9103.

**4.11.2 Standard Deviation**

4.11.2.1 Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with IS 456.
4.11.3 Acceptance Criteria

4.11.3.1 Compressive Strength: The concrete shall be deemed to comply with the strength requirements when both the following condition are met:
   (a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 4.2.
   (b) Any individual test result complies with the appropriate limits in col. 3 of Table 4.2.

4.11.3.2 Flexural Strength
When both the following conditions are met, the concrete complies with the specified flexural strength.
   (a) The mean strength determined from any group of four non overlapping consecutive test results complies with appropriate limit in coloum of Table 11.
   (b) The strength determined from any test result is not less than the specified characteristic strength/0.3 N/mm²

4.11.3.3 Quantity of Concrete Represented by Strength Test Results
The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in col 3 of Table 4.2 or in item (b) of 4.11.3.2. Only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m³.

4.11.3.4 If the concrete is deemed not to comply pursuant to 4.11.1 or 4.11.2 as the case may be for 4.11.3 the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

4.11.3.5 Concrete of each grade shall be assessed separately.

4.11.3.6 If the concrete is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met then concrete is liable to be rejected.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge.

4.11.4 Cement Content of Concrete
4.11.4.1 Minimum cement content in the concrete shall be 330 kg per cubic meter of concrete for all grades of concrete manufactured or produced.

The maximum cement content shall not be more than 500 kg per cubic meter of concrete of the all grade of concrete. These limitations shall apply for all types of cements of all strengths.

4.11.4.2 Actual cement content in each grade of concrete for various conditions of variable shall be established by design mixes within the limits specified in para 4.11.4.1 above.

4.11.5 Water Cement Ratio and Slump
4.11.5.1 The manufacturer or producer/ contractor shall give due consideration to the moisture content in the aggregates while proportioning a particular mix.

4.11.5.2 The mix shall be so designed as to restrict the maximum free water cement ratio to less than 0.5.

4.11.5.3 Due consideration shall be given to the workability of the concrete thus produced. Maximum slump shall be restricted to 100 mm when measured in accordance with IS 1199 while placing the concrete by normal methods.

4.11.6 Approval of Design Mix
4.11.6.1 The producer or manufacturer/ contractor of concrete shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer-in-Charge for his
comments and approval. Concrete of any particular design mix and grade shall be produced or manufactured for works only on obtaining written approval of the Engineer-in-Charge.

4.11.6.2 For any change in quality or quantity in the ingredients of a particular concrete, for which mix has been already designed and approved by the Engineer-in-Charge, the mix has to be redesigned and approval obtained again.

4.12 READY MIXED CONCRETE as per IS 4926

4.12.1 General Requirements

4.12.1.1 Basis of Supply: Ready-mixed concrete shall be supplied having the quality and the quantity in accordance with the requirement agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with requirements of IS 456.

All concrete will be supplied and invoiced in terms of cubic meters (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

4.12.1.2 Transport of Concrete: Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water.

The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by vibration. If required by the purchaser (Engineer-in-charge) the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser (Engineer-in-charge) to place the concrete as rapidly as possible. The purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 minutes of arrival on site.

Concrete shall be transported in a truck-mixer unless the purchaser (Engineer-in-charge) agrees to the use of non-agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

4.12.1.3 Time in Transport: The general requirement is that concrete shall be discharged from the truck-mixer within 2 h of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable. Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

Materials used in ready mixed concrete are cement, Mineral Admixtures, Aggregates & water:-

(a) **Cement:** Cement used for concrete shall be in accordance with the requirements of IS 456.

(b) **Mineral Admixtures:** Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

(c) **Aggregates:** Aggregates used for concrete shall be in accordance with the requirement of IS 456. Unless otherwise agreed testing frequencies for aggregates in plant shall be as given in IS 4926 (for ready mixed concrete).

(d) **Water:** Water used shall be in accordance with the requirement of IS 456. The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer’s production staff and truck-mixer, drivers shall be made aware of the appropriate responses to variations in concrete consistency of a particular mix caused by normal variations in aggregate moisture content or grading.

(e) **Chemical Admixtures**

(i) Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.

(ii) It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect.

(iii) Admixtures should be stored in a manner that prevents degradation of the product and consumed
within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content. (iv) When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket. (v) The amount of admixture added to mix shall be recorded in the production record, in special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

4.12.2 Selection and Approval of Materials
(i) Selection and Approval of Materials: The selection and use of materials shall be in accordance with IS 456.
(ii) Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained.
(iii) Account should be taken of possible interactions and compatibility between IS 4926 (for ready mixed concrete) and materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

4.12.3 Sampling and Testing of Ready-Mixed Concrete
4.12.3.1 Point and Time of Sampling : For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser’s vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered as per sampling of concrete:
After the truck mixer has re-mixed its delivery on site, allow at least the first one-third of a cubic meter of concrete to be discharged prior to taking any samples. Take at least 4 incremental samples from the remainder of the toad avoiding sampling the last cubic meter of concrete. Thoroughly re-mix this composite sample either on a mixing tray or in the sampling bucket and proceed with the required testing.

The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying in concrete as per the requirement given in this standard or otherwise agreed to where so permitted in the standard.

4.12.3.2 Workability: The test for acceptance is to be performed upon the producer’s delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producers' vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate:
- Slump ± 25 mm or 1/3 of the specified value, whichever is less.
- Compacting factor : ± 0.03, where the specified value is 0.90 or greater,
  ± 0.04, where the specified value is less than 0.90 but more than 0.80,
  ± 0.05, where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (see IS 9103). Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

4.12.3.3 Specified Strength
(i) Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his sampling and testing or may enter into an arrangement with the producer to provide his testing requirements.
(ii) Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready-mixed concrete industry method of production control should be one sample for every 50 m³ of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456).
In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 72 ± 2 h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

(iii) The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m^3 or 50 batches, whichever is the greater frequency.

4.12.3.4 Additional Compliance Criteria: Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance frequency of assessment, method of test and significance result.

4.12.3.5 Non-Compliance: The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

4.12.4 Information to be supplied by the Purchaser
4.12.4.1 The purchaser shall provide to the producer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements. Prior to supply taking place, it is recommended that a meeting is held between the purchaser and the producer. Its objective to clarify operational matters such as notice to be given prior to delivery, delivery rate, the name of the purchasers authorized representative who will coordinate deliveries, any requirements for additional services such as pumping, on site testing or training, etc.

4.12.4.2 Designed Mixes: Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information as given in IS 4926 Annexure “D” is to be conveyed to the producer. In order to assist in this, the format:-

<table>
<thead>
<tr>
<th>MIX CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade (N/mm²) (Characteristic strength)</td>
</tr>
<tr>
<td>Minimum Cement Content (kg./m³)</td>
</tr>
<tr>
<td>Mineral Additives (Pulverized fuel ash/Slag/Others) (kg/m³)</td>
</tr>
<tr>
<td>Maximum Free water Cement Ratio</td>
</tr>
<tr>
<td>Nominal Maximum Aggregate size</td>
</tr>
<tr>
<td>Cement Type and Grade (if preferred)</td>
</tr>
<tr>
<td>Target workability (Slump) (mm)</td>
</tr>
<tr>
<td>Target workability at site</td>
</tr>
<tr>
<td>Maximum Temperature of Concrete at the time of placing</td>
</tr>
<tr>
<td>Class of sulphate Resistance (if applicable)</td>
</tr>
<tr>
<td>Exposure condition (if applicable)</td>
</tr>
<tr>
<td>Class of finish (if applicable)</td>
</tr>
<tr>
<td>Mix Application</td>
</tr>
<tr>
<td>Method of Placing</td>
</tr>
</tbody>
</table>
Any other requirements (early strength workability retention, permeability testing, chloride content restriction, maximum cement content, etc.)

Concrete Testing (Frequency)

Material’s Testing (any non-routine requirements)

Alternatives to be offered: Yes/No

Method of Curing to be used by contractor

Quantity (m³)

Note: Additional proforma for further information may be used, such as for specific test rates to be achieved for concrete or raw materials, exact method statements of the contractors proposed site practice.

4.12.4.3 Prescribed Mixes: The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format as above may be followed with suitable modifications as applicable to prescribed mixes.

4.12.5 Information to be supplied by the Producer

When requested, the producer shall provide the purchaser with the following information before any concrete is supplied:
(a) Nature and source of each constituent material,
(b) Source of supply of cement,
(c) Proposed proportions or quantity of each constituent/m³ of fresh concrete.
(d) Generic type(s) of the main active constituent(s) in the admixture.
(e) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture.
(f) Where more than one admixture is used, confirmation of their compatibility and
(g) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

4.12.6 Production and Delivery: The production Ready Mixed Concrete shall be done as per IS 4926 by the producer.

4.12.6.1 Materials Storage and Handling

(i) Cement: Separate storage for Different types and grades of cement shall be provided. Containers may be used to store cement of different types provided these are emptied before loading new cement. Bins or silos shall be weatherproof and permit free flow and efficient discharge of the cement. Each silo or compartment of a silo shall be completely separate and fitted with a filter or alternative method of dust control. Each filter or dust control system shall be of sufficient size to allow delivery of cement to be maintained at a specified pressure, and shall be properly maintained and prevent undue emission of cement dust and prevent interference with weighing accuracy by build up of pressure. Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them and where cement can be stored and retrieved without undue damage to the bags. The bags are to be protected from becoming damp either from the ground or the weather. The cement is to be used in the order it is delivered (see also IS 4082).

In case, the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it falls to conform to any of the requirements given in the relevant Indian Standard.

(ii) Dry Pulverized Fuel Ash and Other Mineral Admixtures: Suitable separate arrangement for storage of pulverized fuel ash, silica fume, metakeolin, rice husk ash, ground granulated blast furnace slag such as for cement, shall be provided, in the plants utilizing these materials.

(iii) Aggregates (Coarse and Fine): Stockpiles shall be free draining and arranged to. Avoid contamination and to prevent intermingling with adjustment material. Handling procedures for loading
and unloading aggregates shall be such as to reduce segregation to a minimum. Provision shall be made for separate storage for each nominal size and type of aggregate and the method of loading of storage bins shall be such as to prevent intermingling of different sizes and types. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum (see also IS 4082 and IS 456).

(iv) Water: An adequate supply shall be provided and when stored on the plant such storage facilities shall be designed to minimize the risk of contamination.

(v) Chemical Admixtures: Tanks or drums containing liquid admixtures shall be clearly labeled for identification purposes and stored in such a way to avoid damage, contamination or the effects of prolonged exposure to sunlight (if applicable). Agitation shall be provided for liquid admixture, which are not stable solutions.

4.12.6.2 Batching Plants and Batching Equipment: Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable container freely suspended from a scale or other suitable load-measuring device and equipped with a suitable discharging mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached the material may be added at controllable rate and shut off precisely within the weighing tolerances specified in the format as below:

4.12.6.3 Delivery Ticket: Immediately before discharging the concrete at the point of delivery, the producer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed invoicing as per the format as below:

DELIVERY TICKET INFORMATION

D-1 The following information shall be included in the delivery ticket to accompany the load to the purchaser:

(a) Name or number of the ready-mixed concrete depot
(b) Serial number of the ticket
(c) Date
(d) Truck number
(e) Name of the Purchaser
(f) Name and location of site
(g) Grade or mix description of the concrete
(h) Specified target workability
(i) Minimum cement content (if specified)
(J) Type of cement and grade (if specified)
(k) Maximum free water-cement ratio (if specified)
(l) Nominal maximum size of aggregate
(m) Generic Type or name of any chemical and mineral admixtures included.
(n) Quantity of concrete in m³
(o) Time of loading
(p) Signature of the plant operator
(q) A statement warning the purchaser of the precautions needed to be taken when working with cement and wet concrete.

D-2 On site the following information will be added:

(a) Time of arrival on site.
(b) Time when discharge was completed,
(c) Any water/admixture added by the supplier to meet the specified workability.
(d) Any extra water/admixture added at the request of the purchaser of the concrete, or his representative, and his signature.
(e) Pouring location.
(f) Signature of the purchaser or his representative conforming discharge of the load.

4.12.7 Quality Control
Quality control of ready-mixed concrete may be divided into three components, forward control, immediate control and retrospective control.

4.12.7.1 Forward control: Forward control and consequent corrective action are essential aspects of quality control. Forward control includes the following.
(i) Control of purchased material Quality
(ii) Control of Materials storage
(iii) Mix design and mix design modification
(iv) Transfer and Weighing Equipment: The producer shall be able to demonstrate that a documented calibration procedure is in place. The use of elector-mechanical weighing and metering systems, that is, load cells, flow meters, magmeters, etc., is preferable over purely mechanical system, that is, knife edge and lever systems.
(v) Plant mixers where present and truck mixers used shall be in an operational condition.

4.12.7.2 Immediate Control: Immediate control is concerned with instant action to control the quality of the concrete being produced or that of deliveries closely following. It includes the production control and product control.

(i) Production Control: The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specifications that has formed the basis of the agreement between the producer and purchaser.

Each load of mixed concrete shall be inspected before dispatch and prior to discharge.

The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.

For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

Regular routine inspections shall be carried out on the condition of plant and equipment including delivery vehicles.

(ii) Product Control: Concrete mixes shall be randomly sampled and tested for workability and where appropriate, plastic density, temperature and air content. Where significant variations from target values are detected, corrective action shall be taken.

It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (see IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forward control by suitable modifications to mix design.

4.12.7.3 Retrospective Control: Retrospective control is concerned with those factors that influence the control of production. Retrospective control may cover any property of materials or concrete, such as aggregate grading, slump, or air content, but is particularly associated with 28-day cube strength because by its very nature it is not property which can be measured ahead of, or at the time of, manufacture.

4.12.7.4 Mix Performance: The producer shall be responsible for ensuring that suitable control procedures are in place to ensure the strength of design mix to the level required as per IS 456 and shall be based on random test of mixes which form the major proportion of production. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.

4.13 PLACING CONCRETE BY PUMPING
4.13.1 General
Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged direct into the desired area is termed as pumped concrete.

Methods of applying pressure to concrete by pumps are:-
(A) Piston type pumps
(B) Squeeze pressure type pumps.
Compressed air pressure pumps shall not be used in the works.

4.13.2 Pumping Equipments
4.13.2.1 Piston Pumps: Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin-piston pump.
The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concrete into the pipe line to maintain a reasonably steady flow of concrete. Single pistol pumps shall not be acceptable.

Inlet and outlet valve shall be any one of the following types:
- Rotating plug type
- Sliding plate type
- Guided plunger type
- Swing type
- Flapper type
- or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water.

The receiving hopper shall have a minimum capacity of one cum and the hopper shall be fitted with remixing rotating blades capable of maintaining consistency and uniformity of concrete.

The primary power for pumps may be supplied by gasoline, diesel, or electric motors. The primary power unit and the pump unit may be truck, trailer or skid mounted.

4.13.2.2 Squeeze Pressure Pumps: Squeeze pressure pumps shall consist of a receiving hopper fitted with re-mixing blades. Re-mixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper.

The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum.

The drum shall be maintained under a very high degree of a vacuum during operation. The drum shall be so fitted with hydraulically operation metal rollers, which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

4.13.2.3 Effective Range and Discharge of Pumps: Effective range of pumps to be used in the work shall be decided after studying the site conditions. However, the minimum horizontal range shall not be less than 150 meters and minimum vertical range shall not be less than 50 meters.

Selection of pumps bases on discharge capacity shall be decided after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from the Engineer-in-Charge. As a guide line figure the contractor may assume a discharge capacity of 15 cubic meter/hour/pump:

4.13.2.4 Pipe Lines: All concrete carrying pipe lines shall generally be rigid pipe lines. Flexible pipe lines may only be used at bend curves in lines or at discharge ends if required. Placements of flexible units shall be done judiciously and connected to the pipe lines only when it meets the approval of the Engineer-in-Charge.

(i) Rigid Line/ Hard Line/ Slick line: Such lines shall be made either of steel or plastic. Aluminum alloy pipes shall not be used.
Minimum pipeline diameter shall be 100 millimeters and shall have normal maximum length of 3 meter in each section connected through couplers.

(ii) Flexible Pipe Line: Flexible lines shall be made out of rubber or spiral wound flexible metal or plastic. The pipe shall again be such that they are in sections of 3 meter length each and connected through couplers. These pipes shall be such that they are interchangeable with rigid lines. While installing flexible units, care shall be taken that there are no links in the pipeline, which is a normal tendency with these pipes having diameter 100 mm and above.

4.13.2.5 Couplers: Couplers to be used for connecting pipe line sections (either hard or flexible) shall have adequate strength to withstand stresses due to handling, misalignments, poor support to pipe lines etc.
For horizontal runs of pipes and for vertical run upto 30 meter height the couplers shall be rated for a minimum pressure of 35 kg/ cm square. Couplers used for rising runs between 30 meter and 50 meter heights shall have a minimum pressure rating of 50 kg/cm square. Couplers shall be designed to allow for replacement of any pipe section without displacing other sections. These shall provide for the full internal cross section. These shall provide for the full internal cross section with no constructions or service. Which may disrupt the smooth flow of concrete. For pipelines of size 150mm and above, double logged type coupler with a thick rubber gasket and secondary wedge-take-up is recommended.

Types of couplers that may be used shall be any of the following:
- Grooved end coupler
- One piece extended lever swing type couplers
- And full flow oil line type couplers.

4.13.2.6 Other Accessories ; Other accessories which shall be catered for, are as under:-
(a) Back up pump of rigid and flexible pipes of varying lengths of similar rating/specifications
(b) Curved sections of rigid pipes
(c) Swivel joints and rotary distributors
(d) Pin and gate valves to prevent back flow in pipe lines
(e) Switch valves to direct the flow into another pipe line
(f) Connection devices to fill forms from the bottom up
(g) Splints, rollers, and other devices for protection of conduit over rock concrete Reinforcing steel and form and to provide lifting and lashing points in the pipe line.
(h) Transitions for connecting different sizes of pipe sections
(i) Air vents for downward pumping.
(j) Clean out equipment.

For concreting of columns, walls and scattered small placement, recommendation is made for special cranes or power controlled booms carrying pipe lines with a pendant type concrete delivery hose.

4.13.2.7 Lubricating of Pipe Line
Before pumping concrete into the pipeline, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipelines. As a guide line, for a 100 mm diameter pipe line of 100 meter length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirements.

The quantity of mortar that comes out of the delivery end of the pipeline shall not be used in place of the concrete work. However, with the approval of Engineer-in-Charge, this mortar may be used as bedding mortar against construction Joints. The rest of the mortar shall be wasted.

Lubrication shall be maintained as long as the pumping of concrete continues.

4.14 GUIDELINES FOR FIELD PRACTICE
4.14.1 General Precautions
(i) Proper planning of concrete supply, pump locations, line layout, placing sequence and the entire pumping operation will result in savings of time and expense.

(ii) The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free of obstructions to allow for movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it. If the surface is a suspended slab, the truck route shall be adequately supported in consultation with the Engineer-in-Charge.

(iii) Pipe lines from the pump to the placing area shall be laid with minimum number of bend. For large placement areas, alternate lines shall be installed for rapid connection when required. A flexible pipe at the discharge end will permit placing over a large area directly without re-handling of pipelines. The pipeline shall be firmly supported.

(iv) If more than one size of pipe must be used, the smaller diameter pipe shall be placed at the pump end and the larger diameter at the discharge end.

(v) When pumping downwards, an air release valve shall be provided at the middle of the top bend to
prevent vacuum or air buildup. Similarly, while pumping upwards, a non-return valve shall be provided near the pump to prevent the reverse flow of concrete.

(vi) It is essential that direct radio/telecommunication be maintained between the pump operator and the concrete placing crew. Good communication between the pump operator and the batching-plant is also essential. The placing rate shall be estimated by the pump operator so that concrete can be ordered at an appropriate delivery rate.

(vii) The pump shall be started for a check run and operated without concrete to ensure that all moving parts are in operation properly. Before placing concrete, the pump shall be run with some grout/mortar for lubricating the line.

(viii) When concrete is received in the hopper, the pump shall be run slowly until the lines are completely full and the concrete is steadily moving. A continuous pumping must be ensured, because, if the pump is stopped, concrete in the line may be difficult to move again.

(ix) When a delay occurs because of concrete delivery or some form repair works or for any other reason, the pump shall be slowed down to maintain some movement of concrete in the pipe line. For longer delays, concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with intermittent strokes of the pump. It is sometimes essential to run a return line, back to the pump so that concrete can be re-circulated during long delays.

(x) If after a long delay, concrete cannot be moved in the line, it may be necessary to clean out the entire line. However, quite often only a small section of pipe line may be plugged and requires cleaning. The pump operator who knows such details as the length of line, age of concrete in the line etc., should be depended upon to aid in deciding the appropriate section to be cleaned.

(xi) When the form is nearly full, and there is enough concrete in the line to complete the placement the pump shall be stopped and a "go devil" inserted at the appropriate time so that concrete ahead of the go-devil shall be forced completion of the work. The go-devil shall be forced through the pipeline to clean it out. Use of water pressure is a safer method. The go-devil shall be stopped at the discharge end to ensure that water does not spill on the placement area, if air pressure is used, extreme care shall be taken and the pressure must be carefully regulated. A trap shall be installed at the end of the line to prevent the go-devil being ejected as a dangerous projectile. An air release valve shall also be installed in the line to prevent air pressure build up.

(xii) It is essential to clean the line after concrete placing operation is complete. Cleaning shall be done in the reverse direction from the form work end to the pump-end where the concrete in the fine can be dumped in bucket. After removal of all concrete, all pipe lines and other equipments shall be cleaned thoroughly and made ready for the next use.

4.14.2 Information to be submitted by the contractor with their bid
Along with their bid the contractors shall be required to submit the following information regarding the equipments proposed to be used by them:-

(i) Type, number, capacity, range, mounting, nature of primary power used and the operating weight of pump and mounting.
(ii) Manufacturer’s specifications for pipe lines giving pressure ratings, sizes and material for straight and curved sections.
(iii) Manufacturer’s certificates.

4.14.4 Sampling and Testing for Quality Control of Fresh Concrete at Plant
Frequency and number of test shall be finalized by the manufacturer of concrete in consultation with the Engineer-in-Charge for his requirement of the mode of measurement of concrete produced. The Engineer-in-Charge may at his discretion require further tests over the test given below to be conducted on fresh concrete. The manufacturer and the placement contractor shall have to comply with all such requirements.

(a) Slump
(b) Compacting Factor/Workability
(c) Consistency
(d) Weight per cubic meter, cement factor and air content.
### 4.14.4.1 Slump

(i) For concrete totally mixed in a central plant, slump shall be checked at:
   - (a) Immediately during loading of trucks
   - (b) Point of discharge from the delivery truck
   - (c) Final placement location
   - (d) At placement location the slump measured shall conform to the design slump. Manufacturer of concrete shall adjust for loss of slump in transit and establish the requirements of design mix. All slump measurements shall be done within a period of 20 minutes from the time cement is added to the mixer. Placement contractor shall transport concrete from truck discharge point to actual placement location within 10 minutes of delivery, before the final "slump reading is taken at placement location.

(ii) For concrete entirely mixed in transit or for shrink mix concrete, slump reading shall be taken at:
   - (a) Point of discharge from delivery trucks
   - (b) Final placement location

In this case also, the slump measured at the final placement location shall conform to the design slump. The placement contractor shall be responsible for transporting concrete from delivery truck discharge point to final placement location within 10 minutes. However, in this case, the truck shall discharge the concrete within 1 hour and 30 minutes from the time cement is added in the mixer and slump measured at point of discharge immediately on delivery. Manufacturer of concrete shall ensure that the final slump measurement corresponds to the ordered slump.

(iii) For measuring concrete slump at point of discharge from delivery trucks, samples shall be taken from concrete omitting the first and the last 15% of the load. For concrete delivery of placed by pumping, sampling shall be similar to those specified for delivery trucks.

(iv) Slump measurements of ready mix concrete transported by buckets shall be at locations specified in para 5.11.4.1 with same limits on time. Sampling from buckets shall be such that the buckets containing discharge from mixer for the last 15% are omitted.

(v) At placement locations, samples for checking slump shall be collected from every 20 cum of concrete or part thereof placed at location for each type to concrete.

(vi) For all slump checks in the field at least two recordings shall be made and the average value taken as the recorded slump.

(vii) Slump checks for concrete in the laboratory shall be carried out as and when required by the manufacturer of concrete during the mix design stage and during the progress of work for control on field, results-

(viii) Slump readings shall only be a guideline for concrete consistency and shall not be taken as the acceptability criteria for concrete placed at location. All slump test shall be carried out in accordance with IS 1199.

### 4.14.4.2 Compacting Factor

(i) For concrete whose ordered slump is 50 mm or less, compacting factor test shall be conducted at both field and central batch plant in addition to slump tests mentioned above.

(ii) Compacting factor check shall be done in field only at placement location, and shall also be conducted at central batch plant if concrete is totally mixed in plant.

(iii) For this test, sampling shall be done as for slump measurements in field and within the same frame as for slump test.

(iv) Only one compaction factor test shall be conducted for every 20 cum of concrete or part thereof placed at location for each type of concrete. Since the test is sensitive, every care shall be taken to conduct this test totally in compliance with procedure mentioned in IS 1199.

(v) Laboratory tests for determining compacting factor of concrete shall be done as per manufacturer’s requirements for establishing and controlling the design mix of concrete.
(vi) Compacting factor test shall not be taken as an acceptance criteria and shall be treated only as a guideline to workability of concrete.

4.14.4.3 **Consistency of Concrete**: This test shall be performed only at the batching plant laboratory using a Vee-Bee Consist meter, for determining and predicting the slump of concrete. Number and frequency of these tests shall be based on requirements of the manufacturer of concrete. Care shall be taken in producing mix design of required characteristic strengths of concrete within limits of Vee-Bee-Degrees between 1.6 and 4.5 for concrete transported and placed by normal method and between 0.8 and 3.5 for concrete transported and placed by pumping methods.

4.14.4.4 **Weight, Cement Factor and Air contents Test**: Freshly mixed concrete for every type shall be tested in the batch plant laboratory for each batch of concrete produced to determine weight per cubic metre of freshly mixed concrete, cement factor in concrete and the air content of the concrete.

4.14.5 **Sampling and Testing for Quality Control of Hardened Concrete**

(i) Test on cube crushing strength of concrete in accordance and compliance with IS 456 and IS 516 shall done as under:-

(a) Sample of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport and also from concrete transported to placement location.

(b) Test on specimens made form samples collected at placement location shall be considered as field test specimens and results there from shall be the criterion of concrete strength. Test in specimens made from samples at the batch plant shall only be taken as guidelines test. Only in the case of doubtful result, the Engineer-in-Charge may refer to such guideline results for deciding on the quality of concrete.

(c) For truck mix concrete and shrink mix concrete guideline test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose first and last 15% of the load shall be omitted while collecting samples.

(d) Frequency of sampling shall be as given below in Table 4.7 for each grade of concrete of different workability's and for each type of specimens (field test specimens and guideline test specimens) for conducting 28 days crushing strength tests.

<table>
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<tr>
<th>Quantity of concrete Delivered (cum)</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5</td>
<td>1</td>
</tr>
<tr>
<td>6 to 15</td>
<td>2</td>
</tr>
<tr>
<td>31 to 50</td>
<td>3</td>
</tr>
<tr>
<td>51 and above sample for each</td>
<td>4 plus one additional 50 cum or part thereof</td>
</tr>
</tbody>
</table>

Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made test of the sample in accordance with IS 516.

(e) All test specimens shall be made compacted cured and tested in compliance with IS 516 and test result interpreted in accordance with IS 456 for acceptance of concrete strength, field specimens test results shall not be less than values given in Table 4.6.

(f) In addition to 28 day crushing strength test on specimens made at frequencies specified in para 4 above, early strength tests at 7 days shall also be conducted on field specimens as well as guideline test specimens. Frequency of sampling for this set of test shall also be same as those specified in Table 4.8 above. 7 day strength shall conform to values given in Table 4.5. But these test results even if conforming to specified values shall only be taken a guideline values for projecting concrete strength and shall not be construed as conforming to specifications.

(g) For each grade of concrete and for all workability conditions with different water - cement ratios and compositions of admixtures, preliminary test shall be conducted for crushing strength on finalization to design mix for each type of concrete. Such test shall be conducted both at 7 days and 28 days under laboratory conditions. Six test specimens shall be made for 7 days test and six test specimens shall be
made for 28 days test.

Average of the six test results of different periods shall not be less than those specified in Table 4.5.

(h) Crushing strengths on cubes shall also be conducted during the process of finalization of concrete design mix. Frequency and number of such tests shall be as per Mix of requirements of concrete manufacturer.

(i) All test specimens for conducting crushing strength shall be properly labeled for identification indicating:

(i) Date of making specimen
(ii) Grade of concrete
(iii) Placement location exact
(iv) Purchasers order number

(j) In addition to crushing strength test on concrete, the Engineer-in-Charge may call for other tests on hardend concrete. The placement contractor and the manufacturer of concrete shall comply with all such instructions.

(ii) Non-destructive Tests
(a) When the 28 days crushing values on field specimens and/or specimens made for guideline test fall short of specified values, or in case of doubtful placement of concrete, the Engineer-in-Charge shall call for non-destruction tests on the structure. Such tests may be any one or a combination of the following:-

- Rebound hammer test
- Windsor Penetration Probe test
- Pulse velocity (sonic or Ultrasonic) test
- Core test
- Load test

(b) Interpretation of rebound hammer, Windsor Probe and Pulse velocity test results shall rest with the Engineer-in-Charge.

(c) Core test, if ordered by the Engineer-in-Charge, shall be done in accordance with IS 516. Samples for such test shall be taken from locations to be identified by the Engineer-in-Charge and such samples shall be collected in compliance with IS: 1199.

(d) If felt necessary, the Engineer-in-Charge may instruct load testing for any part of the structure based on doubtful concrete strengths. Such test shall be carried out as per details to be provided by the Engineer-in-Charge in consultation with the structural consultants.

(e) The concrete manufacturer/concrete placement contractor shall arrange for all test to be conducted in accordance with these specifications, including all necessary tools, plants, equipment and material, and shall be responsible for conducting all test at his cost.

(f) All test conducted at the field laboratory shall be carried out by qualified technicians employed by the concrete manufacturer/concrete placement contractor, in presence of authorized representative of the Engineer-in-Charge. All test reports and observation reports shall be Jointly-signed by the Engineer-in-Charge authorized representative and the technician conducting such test.

(g) Engineer-in-Charge shall alone decide where such tests are to be conducted. He may instruct tests to be conducted at laboratories other than the field laboratory and such instructions shall be followed without claiming extra charges on this account.

(h) The Concrete Manufacturer/Placement contractor shall set up a laboratory at this own expense which shall have facilities, for conducting all necessary field test on materials and field and laboratory test on concrete. The laboratory shall be staffed by the concrete Manufacturer/Placement Contractor with qualified and experienced scientists and technicians.
Expansion Joints in Long Sun Shade

Typical Details of Expansion Joint at Floor
Twin Beam with Twin Columns

Section A-A ON FLOOR

12 mm open joint in floor staggered from expansion joint filled with bitumen

Slab and T-Beam Construction of Long Length
Typical Details of Expansion Joint Covering on Outer Face of columns (plan)

MASONRY TO BE CONSTRUCTED AFTER PLACING CANTILEVER SLAB

Typical Details of Expansion Joint at Roof & Floor Junction
Typical Details of Expansion Joint at Wall & Beam Junction
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<td>Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement part-I mild steel and medium tensile steel bars.</td>
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5.0 BRICK WORK
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5.1 Definition

**Autoclaved** :-
Steam curing of concrete products, sandlime bricks, asbestos cement products, hydrous calcium silicate insulation products, or cement in an autoclave at maximum ambient temperatures generally between 170 and 215°C.

**Bond** :-
It is the arrangement to tie the brick work together longitudinal and transversely in successive courses. It is usually designed to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is greatest possible amount of lap.

**Bed Joint** :-
It is the Horizontal joint in brick masonry work.

**Block** :-
A concrete masonry unit, any one of the external dimensions of which is greater than the corresponding dimension of a brick as specified in IS: 3952-1978*, and of such size and mass as to permit it to be handled by one man. Furthermore, to avoid confusion with slabs and panels, the height of the block shall not exceed either its length or six times its width.

**Block Density** :-
The density calculated by dividing the mass of a block by the overall volume, including holes or cavities and end recesses.

**Closer** :-
It is the portion of a brick used in constructing a wall, to close up the bond next to the end brick of a course.

**Concrete Block** :
Concrete block shall be referred to by its nominal dimensions. The term ‘nominal’ means that the dimension includes the thickness of the mortar joint. Actual dimensions shall be 10mm short of the nominal dimensions (or 6mm short in special cases where finer jointing is specified).

**Coping** :-
It is the cover over a part of brick masonry to protect from rain water & weathering action.

**Cornice** :-
It is an ornamental or horizontal feature projecting from the face of a wall.

**Course** :-
It is a layer of bricks including mortar.

**Cross joint** :-
It is a joint other than a bed joint normal to the wall face.

**Corbel** :-
It is a cantilever projecting from the face of a wall to form a bearing.

**Efflorescence** :-
It is a powdery incrustment of salts left by evaporation on above or below the surface.

**Header** :-
Header in which a brick laid with its length across the wall.

**Indenting** :-
It is the leaving recesses into which future work can be bonded.

**Jamb** :-
It is the part of the wall at the side of an opening.
Joint:
It is a junction point of bricks

Jointing:
It is the operation of finishing joints as the masonry work proceeds.

Pier:
It is a thickened section forming integral part of the wall placed at intervals along the wall primarily to increase the stiffness of the wall or to carry a vertical concentrated load.

Pillar:
It is a detached masonry support. It can be rectangular, circular, & elliptical etc. In case of rectangular pillar, the breadth shall not exceed three times the thickness and thickness itself shall not exceed more than thrice the length of brick.

Quoin:
It is an external corner in brick work; the term may also denote the brick used to form the quoin.

Sill:
It is a lower boundary of door or window opening in masonry work.

Stretcher:
It is a brick laid with its length in the direction of the wall.

Lap:
It is the horizontal distance between the vertical joints in successive courses is termed as a lap and for a good bond; it should be one-fourth of the length of a brick.

Frog:
It is a mark on the face of brick of size 10 mm to 20 mm to form a key for holding mortar. A pressed brick as a rule has frogs on both the side & hand-made brick has only one frog.

Racking back:
It is the termination of a wall in a stepped fashion is known as the racking back.

String course:
It is a horizontal course projecting from a wall usually introduced at every floor level or windows or below parapet or for architectural appearance to the structure and also keeping off the rain water.

Template:
It is a pattern of sheet metal used as a guide for setting out specific section and shape.

Tooothing:
Tooothing in which a Bricks left projecting in alternate courses to bond with future work.

Wall joint:
It is a joint parallel to the wall face.

5.1.1 GENERAL:
Bricks shall be handmade or machine moulded. Reference may be made to IS 2117 : 1991 for guide on manufacture of handmade common burntclay building bricks. For semi-machanized process of manufacture of common burntclay building bricks, reference may be made to IS 11650 : 1991.

The following information of availability, strength, etc. of different types of bricks in the country would be of use.

(a) Strength of Bricks:- Strength of bricks in India varies from region to region depending upon the nature of available soil and technique adopted for moulding and burning. Some re-search has been done for manufacture of bricks of improved quality from inferior soils, such as, black cotton and moorum, which ordinarily give bricks of very low strength. In Madhya Pradesh bricks are available from strength 25 to 40 kgf/Cm² (2.5 to 4 N/mm²). Burntclay Bricks having compressive strength less than 40
N/mm² (approx 400 kgf/cm²) are covered in IS 1077 : 1992 for higher strength. See IS 2180:1988.

(b) **Strength of Masonry** :- Apart from strength of bricks and grade of mortar, as a general rules, the strength of masonry depends on surface characteristics and uniformity of size and shape or units. Units which are true in shape and size, can be laid with thinner mortar joints, thereby resulting in higher strength. Therefore, for the same brick strength, higher masonry strength can be obtained by better shaped bricks with true edges. For this very reason, ashlar stone masonry, with uses accurately dressed and shaped stones, is much stronger (nearly double) than ordinary coarsed stone masonry.

5.2 **Type of Bricks**:-
**In brick masonry the following types of brick are used**:-
(a) The Common Burnt Clay Bricks shall conform to IS 1077. These shall be machine moulded or hand moulded and shall be free from nodules of free lime, flaws warp age, organic matter & visible cracks. These have a frog 100 mm x 40 mm x 10 mm to 20 mm deep on one side with the manufacturer’s identification mark or initials.

(b) Fly Ash Lime Bricks (FALG Bricks): The Fly Ash Lime Bricks shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with or without frog on one of its flat side. Fly ash shall conform to IS 3812.

(c) Clay Fly Ash Bricks: - The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact, and uniform in shape, colour and have smooth rectangular faces with sharp and square corners. The bricks shall be free from warpage, flaws, visible cracks, nodules of free lime and organic matter, and hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

(d) Calcium Silicate Bricks: - The bricks shall conform to IS 4139. The Calcium silicate bricks shall be sound, compact and uniform in shape, free from organic matter, large pebbles, visible cracks, warpage, and nodules of free lime. Bricks shall be solid and with or without. Frog and made of finely grounded sand siliceous rock and lime.

Sand lime bricks, also called ‘Calcium Silicate’ bricks consist essentially of an intimate mixture of siliceous sand or crushed siliceous rock and lime combined by action of saturated steam under pressure. Coloured sand lime bricks also can be made by adding fast pigments to the raw mix before pressure casting.

(e) Tile Brick: The brick 4 cm height shall be moulded without frogs.

(f) Brick Bats: Brick Bats shall be obtained from well burnt bricks.

(g) Mechanized Autoclave Fly Ash Lime Brick: The autoclave fly ash bricks shall conform to IS 12894. These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. Visually; the bricks shall be sound, compact, and free from organic matters, uniform shape warpage and visible cracks.

The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class ‘C’ hydrated lime of IS 712.

5.3 **Size of Brick**
The brick may be modular or non-modular. Sizes for both types of bricks/tiles shall be as per Table given below. While use of modular bricks/tiles is recommended, non-modular bricks/tiles can also be used where so specified. Non-modular bricks/tiles of sizes other than the sizes mentioned in table below may also be used where specified.
<table>
<thead>
<tr>
<th>Type of Bricks/Tiles</th>
<th>Nominal Size mm</th>
<th>Actual Size mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular Bricks</td>
<td>200 x 100 x 100mm</td>
<td>190 x 90 x 90mm</td>
</tr>
<tr>
<td>Modular tile bricks</td>
<td>200 x 100 x 40mm</td>
<td>190 x 90 x 40mm</td>
</tr>
<tr>
<td>Non-modular tile bricks</td>
<td>229 x 114 x 44mm</td>
<td>225 x 111 x 44mm</td>
</tr>
<tr>
<td>Non-modular bricks</td>
<td>229 x 114 x 70mm</td>
<td>225 x 111 x 70mm</td>
</tr>
</tbody>
</table>

Nominal size includes the mortar thickness.

5.4 Classification of Bricks:
Bricks/Brick tiles shall be classified on the basis of their minimum compressive strength as given below:

(a) Class 40 TM chimney brick/grog or ghol brick: - For this item either selected chimney burnt bricks or ghol bricks are used and superior workmanship than the following varieties is required. The crushing strength when thoroughly soaked in water shall not be less than 40kg/sq.cm.

(b) Class 25 TM chimney brick masonry: - The crushing strength when thoroughly soaked in water shall not be less than 25 kg/sq.cm.

(c) Class 25TM open bhatta or pajaw a burnt brick: - As is clear the only difference between (b) and (c) varies in the method of burning bricks. The crushing strength when thoroughly soaked in water shall not be less than 25 kg/sq.cm.

The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck.

5.4.1 Physical Requirements of bricks:
Compressive Strength: The bricks, when tested in accordance with the procedure laid down in clause 5.5.3 shall have a minimum average compressive strength for various classes as given. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any individual brick tested exceeds the upper limit specified in clause 5.4 for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in clause 5.4 for the purpose of calculating the average compressive strength.

Water Absorption: - The average water absorption of bricks when tested in accordance with the procedure laid down in clause 5.5.4 shall be not more than 20% by weight.

Efflorescence: - The rating of efflorescence of bricks when tested in accordance with the procedure laid down in clause 5.5.5 shall be not more than moderate.

5.5 Sampling of Bricks & Test:
The samples of brick for carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken at random according to the size of lot as given in Table below. The sample thus taken shall be stored in a dry place until tests are made.

5.5.1 The samples shall be taken as below:
(i) Sampling from a Stack: When it is necessary to take a sample from a stack, the stack shall be divided into a number of sections and the required number of bricks drawn from each section. For this purpose bricks in the upper layers of the stack shall be removed.

Note: For other methods of sampling i.e. sampling in motion and sampling from lorries or trucks, IS: 5454 may be referred.

Scale of Sampling and Permissible Number of Defectives for Visual and Dimensional Characteristics are given below in the tabular form: -
### TABLE 5.2

<table>
<thead>
<tr>
<th>No. of bricks in the lot</th>
<th>For characteristics specified for individual bricks</th>
<th>For dimensional characteristics for group of 20 bricks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of bricks to be selected</td>
<td>Permissible no. of defective in the sample</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>2001—10000</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>10001—35000</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>35001—50000</td>
<td>50</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: in case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer-in-Charge.

Scale of Sampling and Criteria for Physical Characteristics: The lot which has been found satisfactory in respect of visual and dimensional requirements shall be next tested for physical characteristics like compressive strength, water absorption, efflorescence as specified in relevant material specification. The bricks for this purpose shall be taken at random from those already selected above. The number of bricks to be selected for each of these characteristics shall be in accordance with relevant columns of Table below.

### TABLE 5.3 Scale of Sampling for Physical Characteristics

<table>
<thead>
<tr>
<th>Lot size</th>
<th>Sample size for compressive strength, water absorption and efflorescence</th>
<th>Permissible No. of defectives for efflorescence</th>
<th>Warpage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>2001—10000</td>
<td>5</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>10001—35000</td>
<td>10</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>35001—50000</td>
<td>15</td>
<td>1</td>
<td>30</td>
</tr>
</tbody>
</table>

Note: In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Engineer-In-Charge.

### LIST OF MANDATORY TESTS

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>Material</th>
<th>Clause</th>
<th>Test</th>
<th>Field/ laboratory Test</th>
<th>Test Procedure</th>
<th>Minimum Qty. of material for carrying out test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Bricks/ Brick Tiles</td>
<td>5.5.2</td>
<td>Testing of Bricks/Brick Tiles for dimensions, Compressive strength, Water absorption and efflorescence</td>
<td>Laboratory</td>
<td>As per 5.5.2.1</td>
<td>As per Table 5.3 and 5.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.1,</td>
<td></td>
<td></td>
<td>As per Clause 5.5.3, 5.5.4 &amp; 5.5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.2,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 5.5.2 Test Procedure for Dimensional Characteristics:

The number of bricks to be selected for inspecting the dimensions and tolerance shall be in accordance with Col. 1 and 4 of Table 5.2. These bricks will be divided into groups of 20 bricks at random and each of the group of 20 bricks thus formed will be tested for all the dimensions and tolerances. A lot shall be considered having found meeting the requirements of dimensions and tolerances if none of the groups of bricks inspected fails to meet the specified requirements.

#### 5.5.2.1 Test Procedure :-
All the blisters, loose particles of clay and small projections shall be removed from the surface of bricks. Each specimen of 20 bricks shall then be arranged upon a level surface successively as indicated in Fig. A, B and C of para below in contact with each other and in straight line. The overall length of the assembled bricks (20 Nos) shall be measured with a steel tape sufficiently long to measure the whole row at one stretch.

**Tolerance** :-
The actual dimensions of bricks when tested as described shall be within the following limits per 20 bricks.

**Modular Bricks**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>3720 to 3880 mm (3800 + 80 mm)</td>
</tr>
<tr>
<td>Width</td>
<td>1760 to 1840 mm (2200 + 40 mm)</td>
</tr>
<tr>
<td>Height (90 mm high brick)</td>
<td>1760 to 1840 mm (1800 + 40 mm)</td>
</tr>
<tr>
<td>Height (40 mm high brick)</td>
<td>760 to 840 mm (800 + 40 mm)</td>
</tr>
</tbody>
</table>

**Criteria for Conformity**
A lot shall be considered conforming to the requirements of dimensions and tolerances if all the groups of bricks are tested to meet the specified requirements.

5.5.3 **Test Procedure for Physical Characteristics** :-
Test for Compressive Strength: -This test shall be done in laboratory.

1. **Specimen**
Five whole bricks shall be taken from the samples as specimens for this test. Length and width of each specimen shall be measured correct to 1 mm.

2. **Apparatus**
The apparatus consists of compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which shall coincide with the centre of the plate.

3. **Procedure**
(a) **Pre-conditioning**: The specimen shall be immersed in the water for 24 hours at 25° to 29° C. Any surplus moisture shall be allowed to drain at room temperature. The frog of the bricks should be filled flush with mortar 1:3 (1 cement: 3 clean coarse sand of grade 3 mm and down) and shall be kept under damp jute bags for 24 hours, after that these shall be immersed in clean water for three days. After removal from water, the bricks shall be wiped out of any traces of moisture.

(b) **Actual Testing**: Specimen shall be placed with flat faces horizontal and mortar filled face upward between three 3 ply plywood sheets each of thickness 3 mm and carefully centered between plates of the testing machine. Plaster of Pairs can also be used in place of plywood sheets to ensure a uniform surface. Load shall be applied carefully axially at uniform rate of 14N/mm² per minute till the failure of the specimen occurs.

4. **Reporting the Test Results**
The compressive strength of each specimen shall be calculated in N/mm² as under:

\[
\text{Maximum load at failure (in N)}
\]
Compresive Strength = ——-

---

Area of Specimen (in sq mm)

In case the compressive strength of any individual brick tested exceeds the upper limit of the average compressive strength specified for the corresponding class of brick, the same shall be limited to the upper limit of the class specified in 5.4 for the purpose of calculating the average compressive strength. Compressive strength of all the individual bricks comprising the sample shall be averaged and reported.

5. Criteria for Conformity
A lot shall be considered having satisfied the requirements of average compressive strength if the average compressive strength specified in 5.4 for the corresponding class of brick tested is not below the minimum average compressive strength specified for the corresponding class of bricks by more than 20%.

Note: - (a) From the test results for compressive strength, the average shall be calculated and shall satisfy the requirements specified in relevant material specification. In case any of the test results for compressive strength exceeds the upper limit for the class of bricks, the same shall be limited to the upper limit of the class for the purpose of averaging.

(b) Wherever specified in the material specification, the compressive strength of any individual bricks tested in the sample shall not fall below the minimum average compressive strength specified for the corresponding class of brick by more than 20%.

(c) The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%.

5.5.4 Test for Water Absorption:-
1. No. of Specimen: - Five whole bricks shall be taken from samples as specimen for this test.

2. Apparatus: - A balance required for this test shall be sensitive to weigh 0.1 percent of the weight of the specimen.

3. Procedure
(a) Pre-conditioning: The specimen shall be allowed to dry in a ventilated oven at a 110°C to 115°C till it attains a substantially constant weight. If the specimen is known to be relatively dry, this would be accomplished in 48 hours, if the specimen is wet, several additional hours may be required to attain a constant weight. It shall be allowed to cool at room temperature. In a ventilated room, properly separated bricks will require four hours for cooling, unless electric fan passes air over them continuously in which case two hours may suffice. The cooled specimen shall be weighing (W₁) a warm specimen shall not be used for this purpose.

(b) Actual Testing: Specimen shall be completely dried before immersion in the water. It shall be kept in clean water at a temperature of 27°C ± 2°C for 24 hours. Specimen shall be wiped out of the traces of water with a damp cloth after removing from the water and then shall be weighed within three minutes after removing from water (W₂).

4. Reporting the Test Results: - The water absorption of each specimen shall be calculated as follows and the average of the five tests shall be reported

\[ \text{Water Absorption} = \left( \frac{W_2 - W_1}{W_1} \right) \times 100 \]

5. Criteria for Conformity: - A lot shall be considered having satisfied the requirements of water absorption if the average water absorption is not more than 20% by weight.

Note: - (a) From the test results for water absorption, the average for the bricks in the sample shall be calculated and shall satisfy the relevant requirements specification in material specification.

(b) The average water absorption of brick when tested shall be not more than 20% by weight.

5.5.5 Test for Efflorescence:-
1. No. of Specimen: - Five whole bricks shall be taken as specimen for this test.
2. Apparatus: - Apparatus required for this test shall be a shallow flat bottom dish containing distilled water.

3. Procedure (actual testing): - The brick shall be placed vertically in the dish with 2.5 cm immersed in the water. The room shall be warm (18°C to 30°C) and well ventilated. The bricks should not be removed until it absorbs whole water. When the whole water is absorbed and the brick appears to be dry, place a similar quantity of water in that dish and allow it to evaporate as before. The brick shall be examined after the second evaporation.

4. Reporting the Test Results: - The rating to efflorescence in ascending order shall be reported as 'NIL', 'SLIGHT', 'MODERATE', 'HEAVY' or 'SERIOUS' in accordance with the following:
(a) NIL: When there is no perceptible deposit of efflorescence.
(b) SLIGHT: When not more than 10 per cent of the area of the brick is covered with a thin deposit of salts.
(c) MODERATE: When there is heavier deposit and covering upto 50% of the area of the brick surface but unaccompanied by powdering or flaking of the surface.
(d) HEAVY: When there is a heavy deposit of salts covering 50% or more of the brick surface but unaccompanied by powdering or flaking of the surface.
(e) SERIOUS: When there is heavy deposit of salts, accompanied powdering and/or flaking of the surface and tending to increase in the repeated wetting of the specimen.

5. Criteria for Conformity: - A lot be considered having satisfied the requirements of efflorescence if for 4 out of the specimen of 5 bricks, the rating of efflorescence is not beyond "Moderate".

5.5.6 Sewer Brick
5.5.6.1 Sewer bricks are intended for the lining of walls, roofs and floors of sewers used for ordinary sanitary (domestic) sewage. The general practice in the country is also to utilize common building bricks in the construction of sewers which is not satisfactory. However, these sewer bricks may not be suitable for sewers dealing with industrial effluent (sewage) for which the use of acid resistant bricks in accordance with IS 4860 may be considered. Sewer bricks shall conform to IS 4885.

5.5.6.2 Dimensions and Tolerances Dimensions: The standard sizes of the sewer bricks shall be as follows:

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>190</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>190</td>
<td>90</td>
<td>40</td>
</tr>
</tbody>
</table>

For sewers of special shapes, such as the oval sewers, the bricks may have to be suitable tapered to conform to the radii of curvature of the arches and barrels and sides of sewers.

Tolerance: The permissible tolerance on the dimensions specified in 6.1.4.2 shall be as follows:

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Total tolerance for 20 bricks</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>190</td>
<td>+80</td>
</tr>
<tr>
<td>90</td>
<td>+40</td>
</tr>
<tr>
<td>40</td>
<td>+40</td>
</tr>
</tbody>
</table>

5.5.6.3 Compressive Strength: The average compressive strength obtained on a sample of sewer bricks when tested in accordance, with the procedure laid down in IS 3495 (Part I) shall be not less than 17.5 N/mm² (175 kg/cm² approximately) and the individual strength of any brick shall be not less than 16 N/mm² (160 kg/cm² approximately).

5.5.6.4 Water Absorption: The average value of water absorption for five bricks after 24 h cold water immersion test when tested in accordance with IS 3495 (Part 2) shall not exceed 10 per cent of the average dry weight of the brick and the absorption for any individual brick shall not exceed 12 per cent.

5.5.6.5 Efflorescence: When the bricks are tested in accordance with the method laid down in IS 3495
(Part 3), the rating of efflorescence shall not be more than 'slight'.

Mandatory Test for Sewer Bricks

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Material</th>
<th>Clause</th>
<th>Test</th>
<th>Field/ laboratory Test</th>
<th>test Procedure</th>
<th>Minimum Qty. of material for carrying out test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Sewer Bricks</td>
<td>5.5.6</td>
<td>Dimensions, Compressive strength, Water absorption and Efflorescence</td>
<td>Laboratory</td>
<td>As per 5.5.2.1, As per Clause 5.5.3, 5.5.4 &amp; 5.5.5</td>
<td>As per Table 5.3 and 5.4</td>
</tr>
</tbody>
</table>

5.5.7. **Burnt Clay Perforated Building Bricks**

5.5.7.1 **General Quality:** The Burnt Clay Perforated Building Bricks shall be made of suitable clay and shall be thoroughly burnt at the maturing temperature of clay. They shall be free from cracks, flaws and nodules of free lime. They shall have rectangular face with sharp straight edge at right angle. They shall be of uniform colour and texture. These Burnt Clay Perforated Building Brick generally should conform to IS 2222.

5.5.7.2 Dimensions and **Tolerances:** The standard size of burnt clay perforated bricks shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Length (L) mm</th>
<th>Width (W) mm</th>
<th>Height (H) mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular</td>
<td>190</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Non Modular</td>
<td>230</td>
<td>110</td>
<td>70</td>
</tr>
</tbody>
</table>

The permissible tolerances on the dimensions shall be as follows:

<table>
<thead>
<tr>
<th>Dimension (mm)</th>
<th>Tolerance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70,90</td>
<td>±4</td>
</tr>
<tr>
<td>110,190</td>
<td>±7</td>
</tr>
<tr>
<td>230</td>
<td>±10</td>
</tr>
</tbody>
</table>

Note: The tolerances specified above shall apply to measurements on individual Burnt Clay Perforated Building Brick.
5.5.7.3 Perforations: The area of perforation shall be between 30% and 45% of the total area of the corresponding face of the Burnt Clay Perforated Building Brick.

The perforation shall be uniformly distributed over the surface. In the case of rectangular perforations, the larger dimension shall be parallel to the longer side of the Burnt Clay Perforated Building Brick. The shorter side of the perforation shall be less than 20 mm in case of rectangular perforations and less than 25 mm diameter in case of circular perforations.

The area of each perforation shall not exceed 500 mm$^2$.

The thickness of any shell shall not be less than 15 mm and that of any web not less than 10 mm.

5.5.7.4 Compressive Strength: The Burnt Clay Perforated Building Bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a minimum average compressive strength of 7 N/ mm$^2$ on net area.

The compressive strength of any individual Burnt Clay Perforated Building Brick tested shall not fall below the minimum compressive strength specified for the corresponding class of Burnt Clay Perforated Building Bricks. The lot shall then be checked for the next lower class of Burnt Clay Perforated Building Brick.

5.5.7.5 Wafer Absorption: The Burnt Clay Perforated Building Bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4); after immersion in cold water for 24 hours water absorption shall not be more than 20 percent by weight.

5.5.7.6 Efflorescence: The Burnt Clay Perforated Building Bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4) shall have a rating of efflorescence not more than ‘slight’.

5.5.7.7 Warpage: The Burnt Clay Perforated Building Bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4) the average warpage shall not exceed 3%.

**Mandatory Test for Burnt Clay Perforate Building Brick**

<table>
<thead>
<tr>
<th>S. NO.</th>
<th>Material</th>
<th>Clause</th>
<th>Test</th>
<th>Field/ laboratory Test</th>
<th>Test Procedure</th>
<th>Minimum Qty. of material for carrying out test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Burnt clay perforated building bricks</td>
<td>5.5.7</td>
<td>Dimensions, Compressive strength, Water absorption and Efflorescence</td>
<td>Laboratory</td>
<td>As per 5.5.2.1</td>
<td>As per Table 5.3 and 5.4</td>
</tr>
</tbody>
</table>

5.6 CLASSIFICATION OF BRICK WORK

5.6.1 The brick work shall be classified according to the class designation of bricks used.

5.6.2 Mortar: -The mortar for the brick work shall be as specified, and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

5.6.3 Soaking of Bricks: The bricks required for masonry work using mud mortar shall not be soaked.

Bricks for cement mortar masonry or lime mortar shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks.

Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours and according to the water absorption.

When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place.
The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

5.6.4 Laying
5.6.4.1 Bricks shall be laid in English Bond unless otherwise specified. In half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved planter ensuring better alignment.

Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

5.6.4.2 The surface for bricks work shall be cleaned with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when lying, each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. It’s inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar.

5.6.4.3 The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances:

(i) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.

(ii) Relative displacement between loads bearing wall in adjacent storey intended to be vertical alignments shall not exceed 6 mm.

(iii) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.

(iv) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.

5.6.4.4 Quions :-
5.6.4.4.1 All quoins shall be constructed accurately. The height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints.

5.6.4.4.2 On the graduated straight edge or storey rod, the position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.

5.6.4.5 The brick work shall be built in uniform layers. During construction of brick wall no part of the wall shall rise more than one meter above the construction level. Parts of wall left at different levels shall be raked back at an angle of 45° or less with the horizontal. Toothing shall not be permitted as an alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

5.6.4.6 Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.

5.6.4.7 Top courses of all plinths, steps, parapets, top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be properly radiated and keyed into position to form cut (maru) corners. Where bricks cannot be cut to the required shape to form cut (maru) corners, cement concrete M-15 Grade (aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.
5.6.4.8 All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.

5.6.4.9 To facilitate taking service lines later without excessive cutting of completed work, sleeves (to be paid separately) shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

5.6.4.10 In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

5.6.4.11 Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating (to be paid separately) shall be provided where indicated.

5.6.4.12 Vertical reinforcement in the form of MS or high strength deformed bars or thermomechanically treated bars as per direction of Engineer-in-Charge, considered necessary at the corners and junction of walls and jamb opening doors, windows etc. shall be encased with cement mortar not leaner than 1:4 or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The dia. of bars shall not be less than 8 mm and concrete grade shall be minimum M-10 (with 20mm aggregate).

5.6.4.13 During construction care shall be taken that edges of Jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpoulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good as per direction of Engineer-in-Charge.

5.6.4.14 In retaining walls, where water is likely to accumulate, weep holes of size 50 to 75 mm shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and have sufficient fall to drain out the water quickly.

Note: The Work of providing loose stone surrounding of weep holes will be payable extra.

5.6.5 The work of cutting chases, wherever required to be made in the walls for housing G.I. pipe, CI pipe or any other fixtures shall be carried out in various locations as per below guidelines:-

5.6.6 Cutting of chases in one brick thick and above load bearing walls.
(i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

(ii) The depths of vertical chases and horizontal chases shall not exceed 1/3 and 1/6 of the thickness of the masonry respectively.

(iii) When narrow stretches of masonry (or short length of walls) such as between doors and windows, cannot be avoided they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration such narrow lengths of walls shall be checked for stresses and high strength bricks in mortar or concrete walls provided, if required.

(iv) Horizontal chases when unavoidable should be located in the upper or lower 1/3 of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one meter in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.

(v) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

(vi) Masonry directly above a recess, if wider than 30 cm horizontal dimension) should be supported on
lintel. Holes in masonry may be provided up to 30 cm width and 30 cm height without any lintel. In the case of circular holes in the masonry, no lintel need be provided for holes up to 40 cm in diameter.

5.6.7 Cutting of chases in half brick load bearing walls.
No chase shall be permitted in half brick load bearing walls and as such no recessed conduits and concealed pipes shall be provided with half brick thick load bearing walls.

5.6.8 Cutting of chases in half brick non-load bearing wall.
Services should be planned with the help of vertical chases. Horizontal chase should be provided only when unavoidable.

5.6.9 Joints
The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measure as follows:
(i) In case of modular bricks conforming to IS 1077 specification for common burnt clay buildings bricks, equal to 39 cm.
(ii) In case of non-modular bricks, it shall be equal to 31 cm.
Note: Specified thickness of joints shall be of 1 cm. Deviation from the specified thickness of all joints shall not exceed 1/5 of specified thickness.

5.6.9.1 Finishing of Joints: The face of brick work may be finished flush or by pointing.
(i) The face joint of the mortar shall be worked out while still green to give a finished surface flush with the face of brick work. The joint shall be squarely raked out to a depth of one cm while the mortar is still green for subsequently plastering.
(ii) The faces of brick work shall be cleaned with wire brush so as to remove any useless mortar on brick during the course of raising the brick work.
(iii) In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

5.6.10 Curing
The brick work shall be constantly kept moist on all faces for a minimum period of seven days & kept watch on the curing period.

5.6.11 Scaffolding
5.6.11.1 General: Scaffolding shall be strong to withstand impact loads, all dead load & live load which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

5.6.11.2 Single Scaffolding: Single Scaffolding is provided where plastering, pointing or any other finishing has been indicated for brick work, in which one end of the put-logs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one meter in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls.

5.6.11.3 Double Scaffolding: Double Scaffolding is provided where the brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

5.6.12 Measurements
5.6.12.1 Brick work shall be measured in cubic meters unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. Areas shall be calculated to the nearest 0.01 sqm and the cubic contents shall be worked out to the nearest 0.01 cum.

5.6.12.2 Brick work shall be measured separately in the following stages:
(i) From foundation to floor one level (Plinth level)
(ii) Plinth (floor one) level to floor two level
(iii) Between two specified floor levels above floor two level
5.6.12.3 Brick work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

5.6.12.4 Walls half brick thick and less shall each be measured separately in square meters stating thickness.

5.6.12.5 Walls beyond half brick thickness shall be measured in multiples of half brick which shall be deemed to be inclusive of mortar Joints. For the sizes of bricks specified in 5.3, half brick thickness shall mean 100 mm for modular and 115 mm for non-modular bricks.

Where fractions of half brick occur due to architectural or other reasons, measurement shall be as follows:
(a) upto 1/4th brick-actual measurements and
(b) exceeding 1/4 brick-full half bricks.

5.6.12.6 String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running meters stating dimensions of each projection.

5.6.12.7 Square or rectangular pillars shall be measured separately in cubic meters in multiple of half brick.

5.6.12.8 Circular pillars shall be measured separately in cubic meters as per actual dimensions.

5.6.12.9 Brick work curved on plan shall be measured like the brick work in straight walls and shall include all cutting and wastage of bricks, tapered vertical joints and use of extra mortar, if any. Brick work curved on plan to a mean radius not exceeding six meters shall be measured separately and extra shall be payable over the rates for brick work in straight walls. Nothing extra shall be payable if the mean radius of the brick work curved in plan exceeds six meters.

5.6.12.10 Tapered walls shall be measured net as walls and extra payment snail be allowed for making tapered surface for brick work in walls.

5.6.12.11 Brick work with brick tiles shall be measured and paid for separately.

5.6.12.12 No deductions or additions shall be done and no extra payment made for the following:-
(a) Ends of dissimilar materials (that is, Joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 m² in section;
(b) Opening up to 0.1 m² in area (see Note)
(c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;
(d) Cement concrete blocks as for hold fasts and holding down bolts;
(e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows; and
(f) Chases of section not exceeding 50 cm in girth.
(g) Bearing portion of drip course, bearing of moulding and cornice.

Note 1: Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.
2: In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

5.6.13 Rate
The rate shall include the cost of labour and materials required for all the operations described above except the vertical reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following:
(i) Rough cutting and waste for brick work curved in plan and for backing to stone or other types of facing.
(ii) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.
(iii) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items.

(iv) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section.

(v) Brick on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six meters.

(vi) Raking out joints or finishing joints flush as the work proceeds;

(vii) Preparing tops of existing walls and the like for raising further new work.

(viii) Rough cutting and waste for forming gables, splays at eaves and the like.

(ix) Leaving holes for pipes up to 150 mm dia. and encasing hold fasts etc.

5.7 BRICKWORK IN ARCHES
5.7.1 The specifications requirement for the brick work in both arches i.e. plain arches and gauged arches shall be as given in clause 5.6. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used. Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussiers. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted. The bricks of the spandrel wall at their junctions with the extrudes of the arch shall be cut to fit the curvature of the arch.

5.7.2 Circular Arches
These shall be either:
(i) Plain arches, shall be built in half brick concentric rings with break joints,
(ii) Gauged arches with bricks cut to or moulded to proper shape.

The arch work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flush with mortar and well pressed into their positions as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall not be less than 5 mm not more than 15 mm.

After the arch is completed, the haunches shall be loaded by filling up the spandrels up to the crown level of the arch. Care shall be taken to load the haunches on two sides of the spandrels.

When the arch face is to be pointed (and not plastered), the face bricks shall be cut to proper shape or moulded, so as to have the joints not more than 5 mm thick. These shall be laid with radial joints to the full depth of the arch. The voussours shall break joints to the full depth of the arch.

5.7.3 Flat Arches:
These shall be gauged arches of brick cut or moulded to proper shape. The extrados shall be kept horizontal and the intrados shall be given slight camber of 1 in 100 of the span. The centre of the arch from which joints shall radiate, shall be determined by the point of the inter-section of the two lines drawn from the ends of the arch at the springing level and at 60° to horizontal.

In flat arches, bricks shall be laid with radial joints to the full depth of arch and voussiers breaking Joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The thickness of the joints shall not exceed 5 mm. Flat arches may be used for the sake of appearance but for purpose of carrying loads of the wall above, these shall be used in conjunction with relieving arches, lintels placed below.

5.7.4 Centering and Shuttering of Arches:
The centering and shuttering for the arch shall be as per approval of Engineer-in-Charge. It shall be strong enough to bear the dead load of the arch and the live loads that are likely to come upon it during construction, without any appreciable deflections.

The shuttering shall be tightened with hard wood wedged or sand boxes, so that the same could be eased without jerks being transmitted to the arch. The sequence of easing the shuttering shall be got approved from the Engineer-in-Charge. The shuttering shall be struck within 48 hours of the completion of the arch but not before 24 hours. This shall be done after the spandrel has been filled in and the arch
5.7.5 Measurements
The length of the arch shall be measured as the mean of the extrados and intrados of the arch correct to a cm. The thickness of the arch shall be measured in multiples of the half brick. The breadth in the direction of the thickness of wall shall be measured as specified. The cubical contents shall be calculated in cubic meter, correct to two places of decimal. For arches exceeding 6 m in spans extra payment shall be made on the actual area of the soffit for additional cost of centering including all strutting, bolting, wedging, easing, striking and its removal.

5.7.6 Rate
The rate is inclusive of the cost of the materials and labour required for all the operations described above.

5.8 HALF BRICK WORK
Brick work in half brick walls shall be done in the same manner as described above in 5.6.4 except that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced, 2 Nos. M.S. bars of 6 mm dia., shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4 (1 cement: 4 coarse sand). Over laps in reinforcement, if any shall not be less than 30 cm.

The mortar interposed between the reinforcement bars and the brick shall not be less than 5 mm. The mortar covering in the direction of joints shall not be less than 15 mm.
5.8.1 Measurements
The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sqm. where half brick wall is joined to the main walls of one brick or greater thickness and measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

5.8.2 Rate
The rate includes the cost of the materials and labour involved in all the operations described above except reinforcement which Is to be paid for separately.

5.9 BRICK TILE WORK
The work shall be done in the same manner as described in 5.6.4 except that brick tile shall be used instead of bricks. The measurement and rate shall be same as specified under 5.6.

5.10 HONEY COMB BRICK WORK
The honeycomb brick work shall be done with specified class of brick lay in specified mortar. AH joints and edges shall be struck flush to give an even surface. The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

5.10.1 Measurements
The length and height shall be measured correct to a cm. Area shall be calculated in square meters correct to two places of decimal. Honeycomb openings shall not be deducted.

5.10.2 Rate: -The rate includes the cost of materials and labour involved in all the operations described above.

5.11 JOINING OLD BRICK WORK WITH NEW BRICK WORK
5.11.1 The old work shall be toothed to the full width of the new wall and to the depth of a quarter of brick in alternate courses if the height of the bricks of old as well as new work is same.

In case the height of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints.

5.11.2 For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a brick in depth shall be cut in the main walls. A space of the three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement.

5.11.3 Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

5.11.4 Measurement: - The height and thickness of vertical face in contact with new work shall be measured to the nearest 0.01 m and the area shall be calculated to the nearest 0.01 sqm.

5.11.5 Rate: -The rate includes the cost of labour and material involved in all the operations described above.

5.12 MOULDING AND CORNICES
5.12.1 The specifications described under 5.4 shall apply in so far these are applicable. Moulding and cornices shall be made with bricks as specified for brick work. The bricks shall be cut and dressed to the required shape as shown in the architectural drawings.

5.12.2 Cornices shall not ordinarily project by more than 15 cm to 20 cm and this projection shall be obtained by projecting each brick course by more than one fourth of the length. For cornices projecting more than 20 cm and requiring more than quarter bricks projection, metal cramps shall be used and paid for separately.

5.12.3 Corbelling shall be brought roughly to shape by plastering with the specified mortar. When the mortar is still green, the moulding shall be finished straight and true with the help of metal templates.
5.12.4 Curing and Protection
The moulding and cornices shall be cured for at least seven days. These shall be protected from the
effects of sun and rain by suitable covering and also from damage during the execution of the work.

5.12.5 Measurements
For the purpose of measurements, the sectional periphery of moulding and cornices (excluding the
portion in contact with wall) shall be measured in centimeters and length in meters (fig. below). The
girth and length shall be measured correct to a cm. No deduction shall be made from the masonry of
wall for the bearing of the moulding and cornices,

Note: 1 The sectional periphery curve ABCDEF.
2. Length FA shall not be measured.

5.12.6 Rate
The rate includes the cost of materials and labour involved in all the operations described above.

5.13 BRICK WORK UNDER WATER OR FOUL CONDITIONS
Brick Work under following conditions:
(i) Work in or under water/or liquid mud;
(ii) Work in or under foul positions

Shall be measured separately for payment of extra rate over and above the quantity measured and paid
under para 5.10.

5.14 EXPOSED BRICKWORK
5.14.1 Facing Bricks
The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime
warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces
with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and
even texture. Unless otherwise specified, facing bricks shall be machine moulded only. As far as
possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with
chipped edges and broken corners shall not be used.

5.14.2 Dimensions and Tolerances
The standard sizes of machine moulded facing bricks shall be as specified in 5.3.

5.14.2.1 The permissible tolerances shall be as under:

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<tr>
<td>Width</td>
<td>± 1.5</td>
</tr>
<tr>
<td>Thickness</td>
<td>± 1.5</td>
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Note: Tolerance and Dimensions for selected hand moulded bricks ± 4 mm in length and ± 3 mm in
width and thickness).

5.14.3 Sampling: - As per Para 5.5.

5.14.4 Physical Requirements
Facing bricks shall be of class designation 75 unless otherwise specified. Average compressive
strength shall not be less than 7.5 N/mm², water absorption shall not exceed 20 percent by weight and efflorescence rating shall be nil when tested in accordance with the procedure laid down in clause 5.5.3, 5.5.4, 5.5.5 and tolerance in dimensions shall be checked as per the procedure as given in clause 5.5.2. Soaking of bricks and laying of bricks and shall be as specified in clause 5.6.3 and 5.6.4.

5.14.5 Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as per 5.6.9.

5.14.6 Curing and scaffolding shall be as specified in previous paras.

5.14.7 Measurements
Exposed brick work in face using machine moulded bricks and selected hand moulded bricks shall be measured separately and the measurement shall be as specified in 5.6.12.

5.14.8 Rate
The rates shall be as specified in 5.6.13 and shall also include the following;
(a) Labour for selecting bricks and wastage of bricks where use of selected hand moulded brick is specified.
(b) Leaving uniform horizontal and vertical grooves of specified depth and providing joints of required thickness using wooden or steel strips as the work proceeds.

5.15 CAVITY WALL
It is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50 mm and not more than 115 mm. Each leaf of the cavity wall shall not be less than 75 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

5.15.1 Metal Ties
These may be of galvanized iron, wrought iron, gun metal, brass, copper, stainless steel or any such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

5.15.2 Bonding Units
These shall be preferably precise R.C.C. units having cross-section as per length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves are 75 mm or 115 mm. If the leaves are more than 115 mm thick, then the length of a unit will be 2 x 115 + width of cavity Precast RCC units shall be provided with 2 no., 6 mm mild steel reinforcement bars tied with 2 no. 3 mm- dia. M.S. wire/hard drawn wire cross bars placed in the centre of units. Cement concrete used in the bonding units shall not be leaner than M-10 (stone aggregate 20 mm nominal size).

5.15.3 Spacing
Metal ties/bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings.

5.15.4 Restrictions
Cavity walls shall not normally be built more than 7.5 meters in height and 9 meters in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

5.15.5 Measurements and Rate
(a) Brick work in cavity walls shall be included and measured with general brick work. The width of the cavity shall not be measured. Skin of cavity wall, half brick thickness shall be measured as and paid as described in para 5.6.12 and 5.8.1.

(b) The forming of the cavity shall be given in square meters stating the width of the cavity and shall
include the metal ties/bonding unit specifying the numbers per square meter.

(c) Labour and material for closing cavities at the jambs, sills and heads of opening shall be as described and measured separately in running meters.

(d) The item shall include use of device for keeping cavity clear and forming the requisite weep and vent holes and nothing extra on this account shall be payable.

5.16 GYPSUM PARTITION PANELS
5.16.1 The material shall conform to IS; 2849.

5.16.2 Dimensions: - As per the item nomenclature.

5.16.3 Laying
(i) Panels are stored in a dry place and water should not come in contact with panels during or after construction. If the panels get wet, they should be dried before use.

(ii) The floor should be perfectly level before laying the first course. All panels must be properly aligned to the plumb. Successive layer of panels must be alternatively staggered so that vertical joints are not in the same line.

(iii) The recommended quantity of Gypsum Bonding Plaster must be used for joints and filling the grooves made for conduits, pipelines, etc. Excess Bonding Plaster must be scooped and removed, so that the joints and the places where the grooves are filled in are flush and even.

(iv) The walls should be dry and sanding done properly especially at joints before the primer is applied so that the surface is even and joints will not be visible after painting. Avoid chasing with chisel and hammer. Use electrical saw or grooving tools for conducting etc.

(v) The recommended span of walls is maximum 6 meters and maximum height is 4.5 meters.

(vi) Gypsum panel can easily be cut with coarse tooth hand saw, electric jigsaw, etc. The panels can be cut, sawn, drilled, milled or dowelled on the Job. For concealed piping and conduit, the depth of groove should not exceed 50 mm. Hammer and chisel techniques to form chases must be avoided.

(vii) Sanding: This application is to make the surface level without undulations. To make the gypsum wall surface level (in particular at joints, where there is excess bonding plaster), do sanding with sand paper at joints and other places, wherever you find uneven surface, otherwise joints will be visible after painting. It is important to sand all joints uniformly.

(viii) Primer Application: The purpose of the primer is to give a better adhesion to the paint and also to reduce consumption of paint on the wall. Water thinkable primers shall be used only.

5.16.4 Measurements
The length and height shall be measured correct to a cm. Area shall be calculated in square meters correct to two places of decimal. No deduction shall be made for ducts, opening made from the standard size of panel.

5.16.5 Rate
The rate shall include the cost of materials and labour involved in all the operations described above.

5.17 BRICK EDGING
5.17.1 The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in 6.1. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and butting the plinth protection. The top face of the brick edging shall be in one level to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specification described in chapter 2.0.
5.17.2 Measurements
The brick edging shall be measured in running meter correct a cm.

5.17.3 Rate shall include the cost of materials and labour involved in all operations.

5.18. Autoclaved cellular (aerated) concrete blocks are used for both load bearing and non-load bearing internal walls, partition and panel walls, inner leaf of cavity walls or as backing to brick masonry and for external load-bearing walls as well as panel walls in steel or reinforced concrete frame construction when protected from weather by rendering or by some other efficient treatment. Autoclaved aerated concrete blocks shall fulfill the requirements of Dimensions and Tolerances, Physical Properties (Density compressive strength & Thermal Conductivity, Material, Sampling & Testing) as per IS 2185 (part 3) : 1984.
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6.0 STONE WORK
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GENERAL:
Use of stone masonry work is practiced from earlier days and natural building stone is available extensively in many parts of the country. The types of stone masonry construction depends on local factors, such as, physical characteristics of the stone, climatic conditions, workmanship, etc. Certain broad principles of laying, bonding, breaking of joints and finish should be complied with in order that masonry develops adequate strength and presents a neat appearance.

Types of Stones
The following Indian Standards on different types of stones used for stone masonry:
(i) IS 1127 : 1970 for Natural building stones.
(ii) IS 1128 : 1974 for Lime stone (slab and tiles).
(iii) IS 3316 : 1974 for Structural granite.
(iv) IS 1130 : 1969 for Marble (blocks, slabs, tiles).
(v) IS 3622 : 1977 for Sandstone (slabs and tiles).
(vi) IS 12440 : 1988 for Pre-cast concrete stone masonry blocks.
(vii) IS 3620 : 1979 for Laterite stone brick.

6.0 Definition
Ashlar Masonry Stone
Ashlar masonry is the stone masonry using dressed square stone blocks of given dimensions having faces perpendicular to each other and laid in courses.

Bed Joint
The joint where one stone presses on another stone is known as the bed joint. (See Fig. 6.1(A)).

Bond
It is an interlocking arrangement of structural units in a wall to ensure stability.

Bond Stone (through Stone) (See Fig. 6.2).
Where selected long stone used to hold a wall together transversely is known as Bond stone.

Corbel
It is a stone bonded well into the wall with part of it projecting out of the face of wall to form bearing surfaces.

Cornice (See Fig. 6.1C).
It is a horizontal moulded projection which crowns or finishes either a wall, any horizontal division of wall, or any architectural feature.

Cramp (See Fig. 6.1B)
It is a small piece of metal or the hardest or toughest stone procurable, sunk in mortises and fixed across, joints as additional ties- The ends of metal cramps are bent at right angles and stone cramps are dovetailed.

Course
It is a layer of stones in wall including the bed mortar.

Dowels
Dowels are the small sections of metal, stone or pebbles bedded with mortar in corresponding mortise in bed or side joint or adjacent stones are known as Dowels.
Hearting
It is the filling which forms the core of a rubble wall.

Jamb
The part of the wall at the side of an opening is known as Jamb.

Joggle
A key between the stones by providing a groove in one stone to take a corresponding concealed projection in the edges on the other stone is known as joggle.

Parapet
A solid or pierced guard wall for flat stone terrace or a balcony (or a bridge) or a curb wall at the lower part of a pitched roof which is exposed to atmosphere on face back and top is known as parapet.

Natural Bed
The plane of stratification that occurs in sedimentary rock is known as natural bed.

Plum stone
It is a selected long stone imbedded vertically in the interior of masonry wall to form a bond between successive courses.

Quoin
A quoin is the external angle of wall or building. The term is also applied to stone specially selected and neatly dressed for forming such angle.
Random
It is an irregular size shape of stone used in masonry.

Reveal
The part of the jamb between the frame and the arris is known as reveal.

Rubble Masonry
It is a masonry built of stones either irregular in shapes as quarried or squared and only hammer dressed and having comparatively thick joints. The stones for rubble masonry shall be angular.

Skewback
It is a sloping surface against which the springing of an arch rests.

Spandrel
It is a space between the haunches below the decking level.

String Course (See Fig- 6.1C)
It is a horizontal band, plain or moulded, usually projecting slightly from the face of wall.

Surfacing or Dressing of Stones
It is the dressing of the stones to have different surfaces as desired.

Template or Bed Block
It is a block of stone or concrete bedded on a wall to distribute the pressure from a concentrated load.

Self Faced Surfaces Stone
The surfaces of stone slabs used for flooring, lintels and roofing etc. as obtained from quarry.

Squared Back Surface stone
Means the surface shall be dressed back at right angles to the face of the stone.

Chisel Drafted Margin Stone
The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cm. Chisel drafted margin shall be punch dressed.

Hammer Dressed Surface Stone
A hammer dressed, hammer faced ,quarry faced and rustic faced stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer. The bushing from the general wall face shall not be more than 40 mm on exposed face and 10 mm on faces to be plastered.

Rock Faced Surface stone
A rock faced stone shall have a minimum of 25 mm wide chisel drafted margin at the four edges all the edges being in the same plane.

Rough Tooled Surface stone
A rough tooled surface shall have a series of bands, made by means of a plane chisel 4 to 5 cm wide, more or less parallel to tool marks all over the surface. These marks may be either horizontal, vertical or at an angle of 45°. The edges and corners shall be square and true. The depth or gap between the surface and straight edge, held against the surface shall not be more than 3 mm (Rough tooled stones are used where fairly regular plane faces are required for masonry work).

Punched Dressed Surface stone
A rough surface is further dressed by means of punch chisel to show series of parallel ridges. The depth of gap between the surface and a straight edge held against the surface shall not exceed 3 mm. Punched dressed stones are used where even surfaces are required.
Close Picked Surface stone
A punched stone is further dressed by means of point chisel so as to obtain a finer surface, ridges or chisel marks left over being very tiny. The depth of gap between the surface and a straight edge kept over the surface shall not exceed 1.5 mm.

Fine Tooled Surface stone
A Close picked surface is further dressed so that all the projections are removed and fairly smooth surface is obtained. The surfaces shall have 3 to 4 lines per centimeter width depending on the degree of hardness of stone and degree of fineness required. This type of dressing is commonly adopted for Ashlar work.

Polished Surface stone
A Surface having a high gloss finish. The polishing of stones shall be done by rubbing them with suitable abrasive, wetting the surface where necessary with water. Alternatively polishing of stones shall be done by holding them firmly on the top of revolving table to which some abrasive material like sand or carborundum is fed. The final polishing shall be performed by rubber or felt, using oxide of lime (called by trade name as putty powder) as a polishing medium.

Moulded
Cut to profile of a moulding with punched dressed surfaces, unless otherwise specified.

6.1 Types of Masonry
The following types of masonry are dealt with:
(a) Random rubble masonry - Uncoursed and brought to courses:
(b) Squared rubble
(c) Ashlar, plain:
(d) Ashlar, punched:
(e) Special ashlar; and
(f) Stone veneering

6.1.1 RANDOM RUBBLE STONE MASONRY
6.1.1.1 Stone
The stone shall be of the type specified such as granite, trap, limestone, sand stone, quartzite, etc. and shall be obtained from the quarries, approved by the Engineer-in-Charge. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally stone shall not contain crypts crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. and round surface stone shall not be used.

6.1.1.1 Strength of Stones :-
The strength of building stones shall be adequate to carry the load imposed. For ashlar and coursed rubble masonry, the strength shall be worked as in IS 1905 : 1987, taking into account appropriate compressive strength of stones as given.

The compressive strength of common types of stones shall be as per table given below and the percentage of water absorption shall generally not exceed 5% for stones other than specified in Table below. For literati this percentage is 12%.

<table>
<thead>
<tr>
<th>Type of stone</th>
<th>Maximum Water Absorption Percentage by weight</th>
<th>Minimum Compressive Strength kg./sq.cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granite</td>
<td>0.50</td>
<td>1000</td>
</tr>
<tr>
<td>Basalt</td>
<td>0.50</td>
<td>400</td>
</tr>
<tr>
<td>Lime stone (Slab &amp; Tiles)</td>
<td>0.15</td>
<td>200</td>
</tr>
<tr>
<td>Sand stone (Slab &amp; Tiles)</td>
<td>2.50</td>
<td>300</td>
</tr>
<tr>
<td>Marble</td>
<td>0.40</td>
<td>500</td>
</tr>
<tr>
<td>Quartzite</td>
<td>0.40</td>
<td>800</td>
</tr>
<tr>
<td>Literate (Block)</td>
<td>12.00</td>
<td>35</td>
</tr>
</tbody>
</table>

Note 1.: Test for compressive strength shall be carried out as laid down in IS 1121 (Part 1).
Note 2.: Test for water absorption shall be carried out as laid down in IS 1124.
Physical Properties like water absorption transverse strength durability, etc. which are mandatory tests, shall be done as given below.

**LIST OF MANDATORY TESTS**
(i) Water Absorption, (ii) Transverse strength, (iii) Resistance to wear, (iv) Durability

The Procedure for test, Frequency & Minimum Qty. of material for carrying out tests or given in Table below:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Test</th>
<th>Requirement</th>
<th>Field/ laboratory Test</th>
<th>Test Procedure</th>
<th>Minimum Qty. of material For carrying out test</th>
<th>Frequency of Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Water absorption</td>
<td>Not more than 2.5% by mass for sand stone and as specified in IS 1123 for</td>
<td>Laboratory</td>
<td>IS 1124</td>
<td>50 sqm. for slabs and 10 cum in stone masonry</td>
<td>100sqm/20 cum or part thereof or change of source as per direction of Engineer-in-Charge</td>
</tr>
<tr>
<td>2.</td>
<td>Transverse strength</td>
<td>Not less than 7 N/mm² (70Kgf/cm²) for sand stone and as specified in IS 1123</td>
<td>Laboratory</td>
<td>IS 1121 Part II</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>3.</td>
<td>Resistance to wear</td>
<td>Not greater than 2 mm on the average and 2.5mm for any individual specimen for sand stone and as specified in IS 1123 for</td>
<td>Laboratory</td>
<td>IS 1706</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>4.</td>
<td>Durability</td>
<td>Shall not develop signs of spelling, disintegration or cracks for sand stone and as specified in IS 1123 for other stones,</td>
<td>Laboratory</td>
<td>IS 1126</td>
<td>-do-</td>
<td>-do-</td>
</tr>
</tbody>
</table>

6.1.2 Size of Stones
Normally stones used in masonry should be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall, or not less than 150 mm. The selection and grading of stone shall be done at site stone may be upto 300 mm and smaller stone are used in heating of wall.

6.1.2.1 Uncoursed Random Rubble masonry:
Uncoursed random rubble masonry shall be constructed with stones of sizes as referred above and shapes picked up random from the stones brought from the approved quarry, having sharp corners.
6.1.3 Random Rubble masonry brought to the course:
Random rubble masonry brought to the course is similar to uncoursed random rubble masonry except that the courses are roughly leveled at intervals varying from 300 mm to 900 mm in height according to the size of stones used.

6.1.4 Dressing of Random Rubble masonry Stone:
Each stone shall be hammer dressed on the face, the sides and the beds. Hammer dressing shall enable the stones to be laid close to neighboring stones such that the bushing in the face shall not project more than 40 mm on the exposed face.

(i) **Face stone:** In masonry at least 25% stones shall be headers tailing into the work at least 2/3rd the thickness of wall and shall not be less than 200 sq. cm in cross sections.

(ii) **Hearting Stones:** In masonry the hearting or interior filling of a wall face shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.

(iii) **Quoin Stone:** Quoin stone shall be less than 0.03 cum in volume.

(iv) **Jamb stones:** The jambs shall not be made with stones specified for quoins except that the stones which were required to be provided at 1 meter centre to centre on both the exposed faces shall here be provided only on the jamb and the length shall be equal to the thickness of the wall for wall upto 60 cm and a line of headers shall be provided for walls thicker than 60 cm as specified for bond.
6.1.4.1 Masonry Course/Masonry Layer:
The masonry shall be carried out in regular courses of height not exceeding 50 cm and masonry on any
day will not be raised more than 60 cm in height when using mortars having compressive strength less
than 20 kg./sq. cm at 28 days and 100 cm when using mortars exceeding this strength.

6.1.4.2 Thickness of Joints
The joint thickness shall not exceed 30 mm at any point on the face. Chips of the stone and spalls shall
be wedged into seating bed of face stones to avoid excessive bed thickness. No pinning shall be
allowed to avoid excessive joint thickness.

6.1.5 Mortar
The mortar used for joining shall be as specified.

6.1.6 Laying :- Laying of Stone of Random rubble Masonry shall be as below.
(i) Stone shall be laid on their natural bed and shall be solidly bedded full in mortar with close
joints, chips of stone spalls be wedged into the work wherever necessary.
(ii) No dry work or hollow spaces shall be allowed and every stone whether large or small shall be
carefully selected to fit snugly the interstices between the large stones.
(iii) Masonry shall be built breaking joints in all the three directions.
(iv) Bond stone and headers shall be properly laid duly marked by the contractor with white lead
paint. The bond stones shall be provided as specified in para 6.1.7.
(v) The masonry work in wall shall be carried up true to plumb or to specified batter.
(vi) Random rubble masonry shall be brought to the level courses at plinth, window sills, and lintel
and roof levels.
(vii) Leveling shall be done uniformly with concrete comprising of one part of the mortar as used for
masonry and two parts of graded stone aggregate of 20 mm nominal size.
(viii) Where the masonry of one part is to be delayed, the work shall be raked back at an angle not
steeper than 45°.
(ix) Raking out joints :- All the joints on the faces to be pointed or plastered shall be racked out
with racking tool to a depth of 20mm while the mortar is still green.
(x) Joints :- Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints
shall not be more than 20 mm thick. The joints shall be struck flush and finished at the time of
laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed,
the Joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

6.1.7 Bond Stones
Though bond stones shall be provided in walls upto 600 mm thickness, a set of two or more bond
stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case
of highly absorbent types of stones (porous lime stone and sand stone etc.) the bond stone shall extend
about two-third into the wall, as through stones in such walls a set of two or more bond stones
overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones
shall be provided for every 0.5 m² of the wall surface and shall be provided at 1.5 m to 1.8 m apart clear
in every course.

In case of highly absorbent types of stones (porous lime stone and sand stone etc.) single piece bond
stones may give rise to dampness. For all thicknesses of such walls a set of two or more bond stones
overlapping each other by at least 15 cm shall be provided. Length of each such bond stone shall not
be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available pre-cast cement concrete block of 1:3:6 mix (1
cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) of cross section not less than
225 square centimeters and length equal to the thickness, shall be used 1.5 m to 1.8 m apart in every course.

6.1.8 Quoin and Jamb Stones
The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15 cm. Quoins shall be laid header and stretcher alternatively.

6.1.9 Scaffolding
Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one meter in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1 : 3 : 6 (1 cement: 3 coarse sand : 6 stone aggregate 20 mm nominal size).

6.1.10 Curing
Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

6.1.11 Protection
Green work shall be protected from damage, mortar dropping and rain during construction.

6.1.12 Measurements

6.1.12.1 The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints excluding the bushing. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic meter nearest to two places of decimal.

6.1.12.2 The work under the following categories shall be measured separately.
(i) From foundation to plinth level (level one);
   (a) Work in or under water and or liquid mud,
   (b) Work in or under foul positions.

(ii) Above plinth level and upto floor two levels.
(iii) Above floor five level to every floor/floors or part thereof.
(iv) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

6.1.12.3 No deduction shall be made nor did extra payment make for the following:
(i) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters purlins, trusses, corbels, steps etc.) upto 0.1 sqm in section.

(ii) Openings each upto 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included along with the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded.

(iii) Wall plates and bed plated, and bearing of chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

Note: The bearing of floor and roof shall be deducted from wall masonry.

(iv) Drain holes and recesses for cement concrete blocks to embed hold fasts for doors, windows etc.

(v) Building in masonry, iron fixture, pipes upto 300 mm dia, hold fasts of doors and windows etc.

(vi) Forming chases in masonry each upto section of 350 sq.cm.

6.1.12.4 Masonry (excluding fixing brick work) in chimney breasts with smoke of air flues not exceeding 20 sq. cm (0.20 sq m) in sectional area shall be measured as solid and no extra payment shall be made.
for par getting and coring such flues. Where flues exceed 20 sq dm (0.20 sq m) sectional area, deduction shall be made for the same and par getting and coring flues shall be measured in running meters stating size of flues and paid for separately. Aperture for fire place shall not be deducted and no extra payment made for splaying of jambs and throating.

6.1.12.5 Apertures for fire places shall not be deducted and extra labour shall not be measured for splaying of jambs, throating and making arch to support the opening.

6.1.12.6 Square or Rectangular Pillars: These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

6.1.12.7 Circular Pillars (Columns): These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm.

6.1.12.8 Tapered walls shall be measured net, as per actual dimensions and paid for as other walls.

6.1.12.9 Curved Masonry: Stone masonry curved on plan to a mean radius exceeding 6 meters shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 meters shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

6.1.13 Rate
The rate shall include the cost of materials and labour required for all the operations described above and shall include the following:
(a) Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds.
(b) Preparing tops and sides of existing walls for raising and extending.
(c) Rough cutting and waste for forming gables cores, skew backs or spandrels or arches, splays at eaves and all rough cutting in the body of walling unless otherwise specified.
(d) Bond stones or cement concrete bond blocks.
(e) Leading and making holes for pipes etc.
(f) Bedding and pointing wall plates, lintels, sills etc. in or on walls, bedding roof tiles and corrugated sheets in or on walls.
(g) Building in ends of joists, beams, lintels etc.

6.2 COURSED RUBBLE MASONRY - FIRST & SECOND SORT (FIG. 6.2)

6.2.1 Stone: Shall be as specified in 6.1.0

6.2.2 Size of Stone: Shall be as specified in 6.1.1.

6.2.3 Dressing
Face stones shall be hammer dressed on all beds, and joints so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for at least 80 mm back from the face, and side joints for at least 40 mm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joint. The bushing on the face shall not project more than 40 mm as an exposed face and 10 mm on a face to be plastered, the hammer dressed stone shall also have a rough tooling for minimum width of 25 mm along the four edges of the face of the stone, when stone work is exposed.

Dressing for Second Sort shall be as above except that no portion of dressed surface of joints shall show a depth of gap more than 10 mm from a straight edge placed on it and use of chips shall not exceed 15 per cent of the quantity of stone masonry.

6.2.4 Mortar: - The mortar for Jointing shall be as specified.
6.2.5 Laying
All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearthing or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar; chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearthing stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearthing and these shall not exceed 10% of the quantity of stone masonry.

The masonry in a structure shall be carried up uniformly but where breaks are unavoidable, the joints shall be raked back at angle not steeper than 45°. Tooothing shall not be allowed.

Laying for **Second Sort** shall be as above except that the use of chips shall not exceed 15% of the quantity of stone masonry and stone, in each course need not be of the same height but not more than two stones shall be used in the height of a course.

6.2.6 Bond Stones
Shall be as specified in 6.1.7 except that a bond stone or a set of bond stones shall be inserted 1.5 to 1.8 meters apart, in every course.

6.2.7 Quoins
The quoins shall be of the same height as the course in which these occur. These shall be at least 450 mm long and shall be laid stretchers and headers alternatively. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 100 mm In case of exposed work, these stones shall have a minimum of 25 mm wide chisel drafts at four edges, all the edges being in the same plane.

6.2.8 Joints
All bed Joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

6.2.9 Curing, Scaffolding, Measurements and Rates. Shall be as specified as para 6.1.

6.3  **PLAIN ASHLAR MASONRY** (See Fig. 6.4)

6.3.1.1 Stone shall be of the type specified. It shall be hard, sound, durable and tough, free from cracks, decay and weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials etc. before starting the work, the contractor shall get the stones approved by Engineer-in-Charge.

6.3.1.2 Kota Stone for Veneering
Kota stone shall be of selected quality, hard, sound, dense & homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to requisite size and thickness. They shall be of colour indicated in the drawings or as instructed by the Engineer-in-Charge. The stone shall have the top (exposed) face polished before being brought to site unless otherwise specified. Before starting the work, the contractor shall get the samples of Kota stone approved from the Engineer-in-charge.

**Dressing:** Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it. The thickness of
the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of ± 2 mm shall be allowed for the thickness.

6.3.1.3 Red Sand Stone & White Sand Stone Ashlar Masonry
The stone shall be red or white as specified in the description of item. The stone shall be hard, sound, tough, and free from cracks, decay & weathering. In case of red sand stone, white patches or streaks shall not be allowed. However scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of stone approved by the Engineer-in-Charge.

6.3.2 Size of Stone as specified in 6.1.1.

6.3.3 Dressing
Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings.
A sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved.

6.3.4 Mortar
The mortar for jointing shall be as specified.

6.3.5 Laying
All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of ashlar work without backing of brick work or coursed rubble masonry, face stone shall be laid headers and stretchers alternately unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 30 cm in height and all the courses shall be of same height, unless otherwise specified.

For ashlars facing with backing of brick work or coursed rubble masonry face stone shall be laid in alternate courses of headers and stretchers unless otherwise directed. Face stone and bond stone course shall be maintained throughout. All connected masonry in a structure shall be carried up nearly at one uniform level throughout, but where breaks are avoidable, the joint shall be made in good long steps so as to prevent cracks developing between new and old work. Bond stone provided in the masonry shall be payable in the item of Ashlar masonry. Neither any deduction will be made from the brick masonry for embedding the bond stone in neither the backing nor any extra payment shall be made for any extra labour involved in making holes in brick masonry backing.
When necessary, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these into correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before tying chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work.

6.3.6 Bond Stones: Shall be as specified in 6.1.8.

6.3.7 Joints
All Joints shall be full of mortar. These shall be not more than 6 mm thick. Face joints shall be uniform throughout and a uniform recess of 20 mm depth from face shall be left with the help of the steel plate during the progress of work.
6.3.8 Pointing
All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15 mm.

6.3.9 Curing as specified in 6.1.11.

6.3.10 Protections as specified in 6.1.12.

6.3.11 Scaffolding
Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Fig. 6.4
6.3.12 Measurements
The finished work shall be measured correct to a centimeter in respect of length, breadth and height. The cubical contents shall be calculated in cubic meter nearest to two places of decimal.

6.3.12.1 No deduction nor any extra payment shall be made for the following: as specified in 6.1.13.

6.3.12.2 Square, Rectangular or Circular Pillars as specified in 6.1.12.6.

6.3.12.3 Curved Stone Work: Stone work curved on a plan to a mean radius exceeding six meters shall be measured net and included with general stone work. Stone work circular on a plan to a mean radius not exceeding six meters shall be measured separately and extra payment shall be allowed and shall include all cutting and waste and templates. It shall be measured as the mean length of wall.

6.3.13 Rate
The rate shall include the cost of materials and labour required for all the operations described above. Stone facing or wall lining upto and not exceeding 8 cm thickness shall be paid for under "Stone work for wall lining etc. (Veneer work)". The stone work of thickness exceeding 8 cm shall be paid under relevant items of work.

6.4 PUNCHED ASHLAR (ORDINARY) MASONRY

![Elevation Diagram]

Bond or Through Stone 1500 to 1800 Apart Clear

![Odd Course Diagram]
6.4.1 Stone: Shall be as specified in 6.3.1.1. In case of red or white sand stone, stone shall be red or white as specified in the item. In red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted.

6.4.2 Size of Stone: Shall be as specified in 6.3.2.

6.4.3 Dressing: Shall be as specified in 6.3.3 except that the faces exposed in view shall have a fine dressed chisel draft 2.5 cm wide all round the edges and shall be rough tooled between the drafts, such that the dressed surface shall not be deviate more than 3 mm from a straight edge placed over it.

6.4.4 Other Details
The specifications for mortars, laying and fixing, bond stone, joints, pointing, curing, protections, scaffolding, measurements and rates shall be same as specified in 6.3.

6.5 MOULDED, SUNK, CARVED ASHLAR MASONRY (FIG. 6.6)
6.5.1 Stone: Shall be as specified in 6.3.1.1.

6.5.2 Dressing
Every stone shall be cut to the required size and shape and chisel dressed on all beds and joints so as to be free from any waviness and to give perfectly vertical, horizontal, radial or circular joints with adjoining stones as the case may be. The dressed surface shall not be deviate more than 3 mm from a straight edge placed on it. The face shall be gauged, cut, chamfered, grooved, and rebated sunk or plain moulded and fine tooled as shown in the working drawings. The joints 6 mm from the face shall also be fine tooled so that straight edge laid along it is in contact with every point. It shall be finest surface which can be given to a stone with the chisel and without rubbing.

In case of sunk or moulded masonry, the corner stone shall be dressed at true right angles or true to the shape as specified. The corners being straight and vertical.

For arch, dome or circular work the stone shall be dressed to require wedge shape so that joints shall be truly radial.
6.5.3 Sample
The full size layout of the moulding etc. shall be prepared on platform from which sheet templates shall be cut and the stone dressed to templates to a uniform and fine finish. All visible angles and edge shall be True Square and free from chippings. A sample of dressed stone shall be prepared for approval and it shall be kept as sample after being approved by Engineer-in-Charge.

In case of ashlar moulded and carved columns a full size model of the required moulding, carving etc. shall be prepared in plaster of Paris and kept at site of work as sample work after being approved by the Engineer-in-Charge. The stones shall be moulded and carved in accordance with the approved model to a uniform and fine finish.

6.5.4 Other Details: Shall be as specified in 6.3.5. and 6.3.7 to 6.3.11.

6.5.5 Centering and Shuttering
Centering and shuttering required for arch dome or circular moulded work shall be constructed as directed by the Engineer-in-Charge.

6.5.6 Measurements
The dimensions of the circumscribing rectangles of the dressed stone used in the work shall be measured correct to a cm and cubical contents shall be calculated in cubic meters, nearest to two places of decimal.

6.5.6.1 In case of sunk or moulded work the measurements for the work shall be taken course by course. The plain stone used in conjunction with sunk or moulded stone shall be measured and paid for under the relevant item of stone work.

6.5.6.2 Sunk or moulded work in rectangular, square and circular pillars, moulded cornices and string courses shall be measured under stone work sunk or moulded but extra payment shall be allowed over the general work in each case. No such extra payment shall be allowed for moulded string and plinth courses.

6.5.6.3 in case of arch dome or circular moulded work for arches exceeding six meters in clear span extra payment for additional cost of centering shall be made on the actual area of soffit including strutting, bolting, wedging, easing, striping and removal.
6.5.7 Rate
The rate includes the cost of all materials and labour involved in all the operations described above, including centering and shuttering for arch, dome or circular moulded work.

6.6 STONE VENEERING WORK
Stone lining upto 8 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

6.6.1 Stone: Shall be as specified in 6.3.1.1.
The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

6.6.2 Dressing: Shall be as specified in 6.3.3 except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of ± 2 mm.

6.6.3 Mortar
Mortar for fixing shall be as specified.

6.6.4 Laying
The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort,

6.6.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

6.6.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded. Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of stainless steel or any other metal specified in para 6.6.4.6. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Cramps shall be spaced not more than 60 cm apart horizontally.

Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

6.6.4.3 Cramps may be attached to its sides or top and bottom or sides, top and bottom. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.

6.6.4.4 Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.

6.6.4.5 Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).

6.6.4.6 The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.

6.6.4.7 The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.
6.6.4.8 The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.

6.6.4.9 As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

6.6.5 Joints
The joints shall be done with cement mortar 1:3 (1 cement: 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow grounding is detected by taping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout.

Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement: 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

6.6.6 Other Details
Specifications for pointing, curing, protections and scaffolding shall be specified as para 6.4.4.

6.6.7 Measurements
The length and breadth of the finished work shall be measured in meter correct to cm. The area should be calculated in sq. meter correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radius not exceeding six meters on external face. For radius beyond six meters the work shall be measured as plain work only, even the face may have to be dressed to curve.

6.6.8 Rate
The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

6.7 STONE CHAJJA
6.7.1 Stone slabs shall be hard, sound and durable. These shall be chisel dressed on all faces which are exposed to view and rough dressed at other surface. Angles shall be true and edge lines straight. The finished thickness shall be as stipulated with permissible tolerance of ± 2 mm. The length of stone slabs in chajja shall not be less than 60 cm unless otherwise specified.

6.7.2 In case of sloping chajja the stone shall be sloped as specified. It shall have minimum bearing of 20 cm measured horizontally on the wall and the bearing shall also be similarly sloped. Each slab shall have a hole in the centre of the bearing area through which the anchoring M.S. holding down bolt shall pass. The holding down bolts shall be 12 mm diameter and shall be bent at right angles at its lowest end and buried horizontally for at least 7 cm in a joint 30 cm below the bearing surface. Each holding down bolt shall be secured at top by suitable washer and nut.

The chajjas shall be provided with cove supports, where cove is in brick masonry, it shall project out from the wall as under. 45 cm wide chajja, cove projection 15 cm, depth of cove 3 courses. 60 cm wide chajja, cove projection 20 cm, depth of cove 4 courses. 75 cm wide chajja, cove projection 25 cm, depth of cove 5 courses. 90 cm wide chajja, cove projection 30 cm, depth of cove 6 courses.
6.7.3 In case of horizontal chajja, the stone shall be fixed horizontally with a slight outer slope of about 1 cm. It shall have minimum bearing of 15 cm on the wall. Holding down bolts shall be provided, only where so specified.

6.7.4 Pointing
The joints shall be pointed with 1:2 cement mortar (1cement: 2stone dust) with an admixture of pigment to match the stone shade, and properly cured.

6.7.5 Other Details
Specifications for curing, protections and scaffolding shall be specified in para 6.3.

6.7.6 Measurements
The length and breadth of the finished work shall be measured correct to a cm. The area of chajja projecting beyond the wall shall be calculated in sq m correct to two places of decimal.

In case of sloping chajja, the sloping breadth shall be measured correct to a cm and the area of chajja projecting beyond the wall shall be calculated in sq m correct to two places of decimal.

6.7.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above. Anchoring the coves shall be deemed to be included in the rate, only when it is so stipulated in the description of the item.

6.8 SHELVES, COPING, PLAIN, CORNICES, STRING COURSES ETC.

6.8.1 Stone
Stone shall be of uniform colour and texture and of the kind as stipulated.

6.8.2 Dressing
The exposed faces and sides of shelves shall be chisel dressed such that the dressed surface shall not be more than 3 mm from a straight edge placed on it. All visible angles and edges shall be free from chippings. The surfaces to be burned in the masonry shall be rough dressed.

6.8.3 Laying
These shall be laid in mortar of specified mix and fixed as shown in drawing or as directed by the Engineer-in-Charge,

6.8.4 Other Details
Specifications for pointing, curing, protections and scaffolding shall be as specified under 6.4.4

6.8.5 Measurements
6.8.5.1 Shelves: The length and breadth shall be measured inclusive of bearings correct of a cm. The thickness shall be as specified with permissible tolerance of ± 2 mm. The area shall be calculated in sqm correct to two places of decimal.

6.8.5.2 Copings: The dimensions of the circumscribing rectangles of the dressed stones as used in work shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cu. m.

6.8.5.3 Plain Cornices, String Courses and Plinth Courses: The length, breadth and depth of the stone including bearing shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cu. m.

6.8.5.4 No deduction shall be made from the masonry of wall for the bearing of stone shelves, cornices, string courses.

6.8.6 Rate
The rate shall include the cost of all materials and labour required in all the operations described above.

6.9 STONE JALI
6.9.1 Stone shall be as specified in 6.3.1.1

6.9.2 Dressing and Fixing
The stone shall be cut into slabs of required thickness so as to make jali of the specified thickness. The jali shall be cut as per pattern shown on the drawings. All exposed faces shall be fine tooled to a uniform and smooth finish. Fixing shall be done with the adjoining work in grooves, rebates etc., as shown in the drawing or as directed by the Engineer-in-Charge. A tolerance of ± 2 mm shall be allowed in the specified thickness of the Jali.

6.9.3 Stone jalis shall be fixed in grooves/rebates etc. to adjoining Stone work/Brick work/RCC as shown in the drawing or as directed by Engineer-in-Charge. Necessary sample for the same shall be got approved from the Engineer-in-charge before execution. The breakage of stone jali during fixing shall be the responsibilities of the contractor and replacement shall be provided at his risk and cost.

6.9.4 Measurements
The length and breadth of the stone forming the jali including its borders shall be measured correct to a cm and the area shall be calculated in square meters nearest to two places of decimal.

6.9.5 Rate
It includes the cost of labour and materials required for all the operations described above. It also includes the cost of making grooves or rebates in the adjoining work for fixing Jali.

6.10 DRY STONE CLADDING
6.10.1 Material
Stone for dry cladding shall be of the type as specified in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified in the item. Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of ± 2 mm.

Before starting the work, the contractor shall get the samples of stone approved by Engineer-in-Charge. Approved sample shall be kept in custody of Site-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general Texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work.

6.10.2 Stacking and Storing
Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

6.10.3 Scaffolding
As specified as in para 6.3.11.

6.10.4 Fixing :: Fixing of Stone shall be done as given below.
(i) The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-Charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge.

(ii) The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically along the stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints.
(iii) Stone shall be secured with clamps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

**Jointing of Stone:** Joints horizontal and vertical between the stones shall be filled with weather sealant of make as approved by Engineer-in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

**Protection:** Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction.

**Measurement:** The length and breadth shall be measured correct to a cm. The area shall be calculated in square meter correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

**Rate:** The rate includes the cost of materials and labour involved in all operations described above including cost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps drilling holes / making recesses in stones which shall be paid for separately.

### 6.11 STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification for structural frame work for dry stone cladding are same specifications as for steel work in built up sections (welded or bolted).

#### 6.11.1 Fixing of Frame

The properly designed structural frame for withstanding the weight of stone slab are fixed/supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement concrete including provision of necessary centering/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface.

Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

#### 6.11.2 Measurement

The mode of measurement shall be the same, as specified for steel work in built up section except that the weight of welding material shall not be added in weight of members for payment and nothing extra shall be paid for making holes for temporary fastening of members during erection before welding, which also includes cost of cement concrete block, centering and shuttering and making holes in walls, but excluding the cost of expansion fastener, steel clamps which shall be paid for separately.

#### 6.11.3 Rate

The rate shall include the cost of all labour and material involved in all the operation described above.

### 6.12 ADJUSTABLE STAINLESS STEEL CRAMPS

The cramps shall be stainless steel of make approved by the Engineer-in-charge.

#### 6.12.1 The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 Gms.

#### 6.12.2 Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.

#### 6.12.3 Necessary recessed is required to be done in stone slab which is required to be supported by clamps.

#### 6.12.4 The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.

#### 6.12.5 The rate includes cost of materials and other operations mentioned as above.
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7.0 MARBLE WORK
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7.0 INTRODUCTION
Marble is extensively found at Makrana, Abu, Ambaji, Bar, Kishangarh, Bhainslana, Bundi, Falna, Baroda, Narnaul and in Katni.

Marbles are metamorphic rocks capable of taking polish, formed from the re-crystallization of lime stones or dolomite lime stones and are distinguished from lime stone by even visibly crystalline nature and no flaggy stratification.

Marble slabs are used for flooring, stairs, facing, table tops, etc, and marble tiles are used in floors, dados and skirtings, etc. Marble blocks are either used for monuments or for further converting to slabs or tiles but the detail requirements of marble for flooring are being given in the chapter of flooring.

7.0.1 Marble shall be hard, sound, dense and homogeneous in texture with crystaline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering. Marble is a product of nature hence it is difficult to guarantee uniformity of colour, veining or other characteristics that may be represented in any sample submitted. A sample will indicate only an average of colour, veining and other general texture and specified finish.

7.1 CLASSIFICATION
The marble shall be classified broadly in following two categories :
(a) White Marble, and
(b) Coloured Marble

7.1.1 White Marble
*Raj Nagar (plain white) Marble:* It shall be plain white marble with coarse grains predominantly showing mica particles giving reflection in light.

7.1.2 Coloured Marble
(i) Plain Black Marble
Black marble sawn along veins locally known as ‘Peta Pasu sawing’ available at Bhainslana.

(ii) Black Zebra Marble
(a) *Bhainslana Black Zebra Marble:* Black marble having grey or white veins available at Bhainslana.
(b) *Kishangarh Black Zebra Marble:* Black marble with grey and/or white veins available at Kishangarh.
(c) *Abu Black Zebra Marble:* Black marble having white patches and streaks available at Abu.
(d) *Namaul Black Zebra Marbles:* Black marble with thin white veins available at Narnaul.
(e) *Makrana Dhobi Doongri Zebra Marble:* Greyish black marble with white flowery pattern available at Dhobi Doongri.

(iii) Green Marble
(a) *Baroda Green Marble:* Dark green marble with flowery pattern available at Baroda.
(b) *Abu Green Marble:* Light green marble with green and/or brown streaks on white ground available at Ambaji.
(c) *Falna Green Marble:* Green marble with prominent yellowish pattern available at Falna.
(d) *Bundi Green Marble:* Green marble with pinkish shades available at Umar (Bundi).

(iv) Grey Marble
(a) *Kumari Grey Marble:* Grey marble having light blue shades available at Makrana.
(b) *Bundi Grey Marble:* Grey Marble with pink or green or black streaks available at Umar (Bundi).

(v) Brown Marble
(a) Bar Brown Marble/Brown Marble with light and dark brown shades available at Bar.
(b) Narnaul Brown Marble having teak wood shades available at Narnaul.

(vi) Katni Marble
7.1.3 Granite Stone
It shall be of any colour and size as directed by Engineer-in-Charge. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

7.2 SIZES AND TOLERANCES
The size of marble blocks, slabs and tiles shall be as mentioned as below:

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<td>1.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
</tbody>
</table>

Notes:
(1) All dimensions are in centimeter.
(2) The length and width, of the blocks shall be in multiple of 30 cm.
(3) Length and width of slab shall be in multiple of 10 cm. and thickness in multiple of 1 cm.
(4) Tiles shall be square cut and linear dimensions in multiple of 10 cm.
(5) Only slabs and tiles shall be machine cut and factory made.
(6) For 8 mm thick tiles, special precautions will be required for fixing them like using special adhesive as per manufacturer's specifications. Such tiles are not suitable for outside veneering work exposed to rains/sun if used in large areas in continuous stretches. For tiles of thickness 20 mm and above cramps may be provided if approved by Engineer-in-Charge.

Tolerance
The following tolerances shall be allowed in the dimension of blocks, slabs and tiles:

<table>
<thead>
<tr>
<th>Blocks</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Length</td>
<td>+ 2 per cent</td>
</tr>
<tr>
<td>(b) Width</td>
<td>+ 2 per cent</td>
</tr>
<tr>
<td>(c) Thickness</td>
<td>+ 2 per cent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slabs</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Length</td>
<td>+ 2 per cent</td>
</tr>
<tr>
<td>(b) Width</td>
<td>+ 2 per cent</td>
</tr>
<tr>
<td>(c) Thickness</td>
<td>+ 3 per cent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tiles</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Linear dimension</td>
<td>+ 3 per cent</td>
</tr>
<tr>
<td>(b) Thickness</td>
<td>+ 1 per cent</td>
</tr>
</tbody>
</table>

The sizes other than those mentioned above may be provided as directed by the Engineer-in-Charge and nothing extra shall be payable on this account.

7.3 PHYSICAL PROPERTIES
7.3.1 The physical properties of marble for blocks, slabs and tiles and method of tests are as below:

<table>
<thead>
<tr>
<th>TABLE 7.2 Physical Properties of Marble &amp; Granite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
</tr>
<tr>
<td>(1) Moisture absorption after 24 hrs immersion in cold water</td>
</tr>
<tr>
<td>(2) Hardness</td>
</tr>
<tr>
<td>(3) Specific Gravity</td>
</tr>
</tbody>
</table>

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TABLE 7.3 LIST OF MANDATORY TESTS MARBLE

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Test</th>
<th>Field/ Laboratory Test</th>
<th>Test Procedure</th>
<th>Minimum quantity of material/ work for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture Absorption</td>
<td>Laboratory</td>
<td>IS 1124</td>
<td>50 Sq.m.</td>
<td>100 sqm. or part thereof.</td>
</tr>
<tr>
<td>2.</td>
<td>Hardness Test</td>
<td>-do-</td>
<td>Mho's Scale</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>3.</td>
<td>Specific Gravity</td>
<td>-do-</td>
<td>IS 1122</td>
<td>-do-</td>
<td>-do-</td>
</tr>
</tbody>
</table>

TABLE 7.4 LIST OF MANDATORY TESTS GRANITE

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Test</th>
<th>Field/ Laboratory Test</th>
<th>Test Procedure</th>
<th>Minimum quantity of material/ work for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Moisture</td>
<td>-do-</td>
<td>IS1124</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>2.</td>
<td>Specific Gravity</td>
<td>-do-</td>
<td>IS 1122</td>
<td>-do-</td>
<td>-do-</td>
</tr>
</tbody>
</table>

7.3.2 Approval of Sample
First the contractor shall get samples of marble approved by the Engineer-in-Charge and after approval of sample the work shall be started. Approved samples shall be kept in the custody of the Engineer-in-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

7.4 SAMPLING
(i) In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification.

(ii) The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table as below:

<table>
<thead>
<tr>
<th>TABLE 7.5 Sample Size and Criteria for Conformity</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Number of Blocks slabs/Tiles in the lot</th>
<th>Number of blocks slabs/Tiles to be selected in sample</th>
<th>Permissible number of defectives</th>
<th>Sub sample size in no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Up to 25</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>26 to 100</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>101 to 200</td>
<td>8</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>201 to 500</td>
<td>13</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>501 to 1000</td>
<td>20</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

(iii) The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

(iv) All the blocks/slabs/tiles, selected in the sample, shall be examined for dimensions workmanship and general requirements.

(v) Any block/slab/tile failing in any one or more of the above requirements shall be considered as defective. A lot shall be considered as conforming to these requirements. If the number of defectives obtained is not more than permissible no. of defectives given in Col. 3 of table 7.5

(vi) The lot having been found satisfactory with respect to dimensions, workmanship and general requirement shall be tested for physical properties of the marble. For this purpose a sub sample of the
size given in Col. 4 of Table as above shall be selected at random. These blocks/slabs/tiles in the sub sample shall be tested for moisture absorption, hardness and specified gravity. Considered having satisfied the requirements of the physical properties if none of the tested for the requirements fails in any of these tests.

7.5 MARBLE WORK - TABLE RUBBED AND POLISHED (PLAIN WORK)
Marble work in steps, jambs, columns and other plain work shall be as specified below:-
(i) Joints in staircase treads, kitchen platforms shall be permitted only at curvature or when width/length is more than 0.6/2 mtrs. respectively.

(ii) Number of joints in each direction shall not be more than one number for every 2 mtrs. length beyond the initial 2.00 m length. Additional joints due to curvature or for providing fixture shall be provide judiciously.

7.5.1 Dressing, Cutting and Rubbing
(i) Every marble stone shall be gang saw/machine cut to the required size and shape, chisel dressed machine finished on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radial or circular joints as required.

(ii) The exposed faces and sides of stones forming joints upto 6mm. from the face shall be fine tooled machine cut such that a straight edge laid along the face of the stone is in contact with every point on it. All window sills, tread of steps, counters vanities moulding edges etc. shall be machine cut & polished to give high gloss mirror finish as per direction of Engineer-in-Charge. These surfaces shall then be rubbed smooth.

(iii) All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6 mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted V shape. The surfaces of the stones coming in contact with backing need not be chisel dressed.

(iv) A sample of dressed and rubbed stone shall be prepared for approval and it shall be kept on worksite after being approved by the Engineer-in-Charge.

7.5.2 Mortar
The mortar used for jointing shall be as specified.

7.5.3 Laying
(i) All marble stones shall be wetted before placing in position, then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

(ii) The walls and pillars shall be carried up truely in plumb or battered as shown in the drawings. All courses shall be laid truely horizontal and all vertical joints shall be truely vertical.

(iii) In case of work without backing of brick work or coursed rubble masonry, face stone shall be laid in headers and stretchers alternatively unless otherwise directed.

(iv) The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all courses shall be of the same height unless otherwise specified.

(v) **For work facing with backing of brick work or coursed rubble masonry :-**
(a) For work facing with backing of brick work or coursed rubble masonry, face stone shall be laid in alternate courses of header and stretchers unless otherwise directed.

(b) Face stone and bond stone courses shall have break joint on the face of atleast half the height of the standard course and the bond shall be carefully maintained through out.

(c) All the connected masonry in a structure shall be carried up nearly at one uniform level throughout but where breaks are unavoidable the joints shall be made in good long steps so as to prevent cracks developing between new and old work.
Care being taken that the corners of the stone are not damaged.

Stone shall be covered with gunny bags, before putting chain or rope is passed over it and it shall be handled carefully.

No piece which has been damaged shall be used in work. The matching of grains shall be carried out as directed by the Engineer-in-Charge.

7.5.4 Bond Stone

Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60 cm thick and in case of wall above 60 cm thickness a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face to back.

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the wall surface. All bond stones shall be marked suitably as directed by the Engineer-in-Charge.

7.5.5 Joints

The depth of joints 6 mm from the face shall be uniform and as fine as possible but shall be not more than 1.5 mm thick on the exposed face. Beyond the depth of 6 mm from face, the thickness of joints shall increase in an inverted V shape so as to give good mortar bond between two stones. The inverted, portion of the joints shall be filled with bedding mortar and the face 6 mm portion with pointing mortar.

7.5.6 Curing

The work shall be kept constantly moist on all faces for a period of atleast seven days.

7.5.7 Finishing

After the marble work is cured, it shall be rubbed with carborandum stone of different grades no. 60, 120 and 320 in succession or with electrical rubbing machines rubbed with carborandum items 0 to 6 nos. in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

7.5.8 Protection

Green work shall be protected from rain by suitable coverings, and shall be protected from damage during construction.

7.5.9 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

7.5.10 Measurements

(i) For plain work: Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

(ii) In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimeter and thickness, correct to 0.5 cm. The cubical contents shall be calculated in cubic decimeter nearest to two places of decimal.

(iii) The marble work in arches and domes shall be measured as for plain work, but extra shall be allowed for such work over the rate for plain work.

(iv) Sunk or moulded work in marble shall be measured by volume as per plain marble work or work in arches or domes as the case may be on the basis of circumscribed rectangular block of the finished work but extra shall be paid for such work over the rate for plain work for work in arches and domes. For the purpose of extra payment, volume of every stone sunk or moulded shall be considered.

7.5.11 Rate

The rate includes the cost of materials and labour required for all the operations i/c cutting of recesses in wall cutting moulding corners edge rounding finishing & polishing as specified.
7.5.12 Use of Finished Marble Slabs and Tiles
In case such finished tiles are used, these shall be measured and paid for separately.

7.6 WALL LINING/VEENEER WORK
7.6.1 Unless and otherwise specified in the nomenclature of the item, the marble slabs used for wall lining/veneer work shall be gang saw cut (polished & machine cut) and conform to dimensions given in Table 7.1 above,

Back shall not be polished/ cut in order to ensure a good grip with the hearting of backing. The cut slabs shall be of the thickness as specified with a tolerance permissible under para 7.2 above. The tolerance in wall lining when straight edge of 3 m length is placed should not be more than 2mm.

7.6.2 Laying
(i) The stone shall be wetted before faying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort.

(ii) Care shall be taken to match the grains of veneer work as directed by the Engineer-in-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/streaks.

(iii) Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains.

(iv) Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints.

(v) This shall then be got approved by the Engineer-in-Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location. For the facing of the columns also the same procedure as mentioned above shall be followed.

(vi) Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

(vii) The stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

(viii) Cramps shall be of 25 x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm- In case of backing with brick masonry walls 230 mm or less thick or RCC members cramps shall be of 25 x 6 mm and length as per requirement made out of gun metal, copper alloyed with zinc, tin, nickel, lead or stainless steel. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm.

(ix) Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 7.1.
(x) Typical shape & details of cramps for such backing are as indicated in Fig. 7.2 for general guidance. This can be modified as directed by the Engineer-in-Charge if so, required at site. Cramps shall be spaced not more 60 cm apart horizontally.
The adjoining stones shall be secured to each other by means of gun metal cramps or copper pins of the specified size. Cramps may be attached to its sides (see Fig. 7.3A, 7.3B) or top and bottom (See Fig. 7.3C, D, E, F) or sides, top and bottom (see Fig. 7.3G, 7.3H). The general arrangement of cramps required for fixing facing unit to the wall are illustrated in Fig 7.3. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.
Note: Cramps arrangement is shown above for veneerings with longer sides vertical. For veneerings having the longer sides horizontal cramps would be arranged to suit the altered positions.

(xii) Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facing below to thick facings above.

(xiii) Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramps should be properly designed as per IS 4101 (Part 1).

(xiv) The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

7.6.3 Joints
All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and relaid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5 mm and in the face joint, the top 6 mm depth shall be filled with mortar specified for the pointing.
7.6.4 Mortar
The mortar used for jointing slabs shall be as specified.

7.6.5 Curing, Finishing, Protection and Scaffolding
It shall be as specified under 7.5.6 to 7.5.9.

7.6.6 Measurements
The length and breadth shall be measured correct to a cm. In case of radially dressed or circular slabs used in the work, the dimensions of the circumscribing rectangles of the dressed stone used in the work, shall be measured & paid for. The area shall be calculated in sqm nearest to two places of decimal.

Marble work in lining upto 4 cm thickness shall be paid by area under veneer work and lining of greater thickness paid by volume under plain marble work.

7.6.7 Rate
The rate includes the cost of materials and labour required for all the operations described above except for the cost of providing and fixing of dowel and cramps which shall be paid for separately, unless otherwise stipulated in the item of work.

When factory made finished slabs and tiles are used, no further finishing as mentioned in para 7.5.7 shall be required nor anything extra shall be payable.

7.7 MARBLE STONE FLOORING AND MARBLE STONE IN RISERS OF STEPS AND SKIRTING
Refer to relevant clause in subhead 11.0 of flooring of CPWD Specifications 2009 / subhead 10.0 of flooring of UADD Specifications 2010.

7.7.0 Marble Slab Urinal Partitions
The partitions shall be of marble slab embedded in the wall. The size and shape of the marbles slab shall be as per direction of Engineer-in-Charge. The finished thickness shall be 18 mm. The specifications for marble/granite stone work, in general, shall be as specified. The marble granite stone shall be cut into slabs of required thickness and shall be one piece.

7.7.1 Finishing
The partition of the slab to be embedded in the masonry shall be rough dressed. Dressing and rubbing of the exposed portion of the slab shall be as described. The dressed slab shall be of the thickness as specified with a tolerance of ± 1.5mm. The slab shall be got approved from the Engineer-in-Charge before fixing.

7.7.2 Fixing shall be as specified except that the recess shall be 7.5 cm wide. Fixing shall be done by cutting chase with chase cutter/fine tools in a recess of 7.5 cm X 7.5 cm filled with cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 6mm nominal size). Fixing can also be done by epoxy grout in a chase of 2.0 X 7.5 cm as per direction of Engineer-in-Charge.

7.7.3 Measurement shall be as per para 7.6.6.

7.7.4 Rate shall include the cost of labour and materials involved in all the operations described above including the leaving/cutting of recess in the wall, moulding, curves, edge rounding, finishing and polishing as specified.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>IS No.</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>IS 1122</td>
<td>Method of test for determination of true specific gravity of natural building stones.</td>
</tr>
<tr>
<td>2.</td>
<td>IS 1124</td>
<td>Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.</td>
</tr>
<tr>
<td>3.</td>
<td>IS 1130</td>
<td>Marble (blocks, slabs and tiles).</td>
</tr>
<tr>
<td>5.</td>
<td>IS 3316</td>
<td>Specifications for structural granite</td>
</tr>
<tr>
<td>6.</td>
<td>IS 14223 (Part1)</td>
<td>Polished Building Stones (Part-1) Granite</td>
</tr>
</tbody>
</table>
8.0 WOOD WORK AND P.V.C. WORK
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<td>List of Mandatory Tests</td>
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<tr>
<td></td>
<td>List of Bureau of Indian Standard Codes</td>
</tr>
<tr>
<td>Material</td>
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<tr>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>Timber</td>
<td>8.1.6</td>
</tr>
<tr>
<td>Flush door</td>
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</tr>
<tr>
<td>Mortise Locks</td>
<td>8.15.13</td>
</tr>
</tbody>
</table>
8.0 Definitions

**Air-Dried**: The condition of timber which has been subjected to air seasoning.

**Air-Dry**: A term applied to timber the moisture content of which is in approximate equilibrium with the local atmospheric conditions, irrespective of the method of seasoning.

**Ballies**: These are thin round poles usually without bark.

**Beam**: Is a structural timber generally long in proportion to its width and, thickness and used for supporting load primarily by its internal resistance to bending.

**Board**: Thin planks

**Batten board**: A board having a core made of strips of wood usually 8 cm wide, each laid separately or glued or otherwise joined foot form a slab which is glued between two or more outer veneers with the direction of the grain of the core battens running at right angles to that of the adjacent outer veneers.

**Block Board**: Is a board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers.

**Fiber board**: Sheet material generally exceeds 1.5 mm in thickness, manufactured form lignocelluloses fibers with the primary bond deriving form the felting of the fibers and their inherent adhesive properties. Bonding materials and/or additives may be added.

**Particle board**: A board manufactured from particles of wood or other lignocelluloses material, for example, flakes, granules, shavings and slivers or splinters, agglomerated, formed and pressed together with one or more of the agents, such as heat, pressure, moisture and catalyst.

**Plywood**: A board formed of three or more layers of veneer cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

**Bond**: An adhesive on the wood at the line of application.

**Core**: Means the inner layers of a composite wood product.

**Cross Band**: Is a general term indicating a transverse layer of veneer or veneers in composite wood products.

**Decay**: Disintegration of wood tissues caused by fungi (wood destroying) or micro-organism.

**Durability**: Resistance offered by wood to agents of natural destruction like insects and fungi.

**Elongation**: This term is used to describe the permanent change in the length affected by the load. Elongation is sometimes referred to as permanent.

**Freeze Rail**: Is a horizontal member, mortised or otherwise secured to the stiles of a door, provided just below the freeze panel usually provided for decorative purposes in the uppermost portion of the door.
Joint: Means a prepared connection for joining adjacent pieces of wood veneer etc.

Butt joint: - Joint in which two pieces of timber is joint end to end usually across the grain. Sometimes dowels are used in such a manner that half of the dowel is thrust in each piece.

Combed joint: - A joint formed by series of tenons engage in corresponding slots.

Dovetail Joint: A joint at the corner of two pieces in such a way that the notches made on one are fitted exactly into projections of corresponding size and shape made in the other. There are various kinds of dovetail joints, for instance, lapped dovetail joint and wedge shaped dovetail joint, joint in way which will resist withdrawal accept in the direction in which it was assembled (Fig 8.1c)

Edge joint: - A joint made between two pieces of timber or veneers in the general direction of the grain.

Lap joint: - A joint in which two pieces of timber are jointed in such a way that one over laps the other & the entire surface may or may not remain continuous.

Halved joint: - A lap joint in which the timber is reduced to half section to certain length it one end in both the pieces, which are lapped on lapped one on another end joined.

Mitered Joint: Means a joint, between two members at an angle which bisects the joining angle usually the joining faces are cut at 45° to form a right angle (Fig. 8.1B).
Mortise and Tenon Joint: Means a joint in which the reduced end (tenon) of one member fits into the corresponding slot (mortise) in another member (Fig. 8.1D).

Tongue and Groove Joint: Means a joint in which a tongue is provided on edge of one member to fit into a corresponding groove on the other (Fig. 8.1A).

Joist: - A beam directly supports floor, ceiling or roof of a structure.

Kiln: - A chamber in which temperature, humidity and circulation of air may be controlled for seasoning timber.

Knot: Means the base of a branch or limb embedded in the tree which becomes visible when it is cut.

Diameter of Knot: - The maximum distance between two points farthest apart on the periphery of a round knot, on the face where it becomes visible. In the case of a spike or splay knot, the maximum width of the knot visible on the face on which it appears shall be taken as its diameter.

Moisture content: - The mass of water present in wood for other material expressed as a percentage of it oven-dry mass.

Mortise: - A hole or slot to receive a tenon or dowel of corresponding size.

Muntin: Means Small horizontal or vertical dividing bars within basic framework of a door, or window subdividing and supporting the glass panes or panels of doors and windows.

Particle: Means distinct particle or fraction of wood, or other lignocelluloses material produced mechanically for use as the aggregate for making a particle board. This may be in the form of flake, granule, shaving, splinter and sliver.

Pith: - Soft tissues found near about the center of the log, also called center core of the tree.

Plywood: Means a board formed of three or more layers of veneers cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

Principal rafter: - A roof member which supports purlins.

Rebate: Means a recess along the edge of a piece of timber to receive another piece or a door, sash or a frame.

Sapwood: Means the outer layers of the log, which in the growing tree contain living cells and feed material. It is usually lighter in colour, and is readily attacked by insects and fungi.

Seasoning: A process involving the reduction of moisture content in timber under more or less controlled conditions towards or to an amount suitable for the purpose for which it is to be used.

Seasoned Timber: Timber whose moisture content has been reduced to the specified minimum, under more or less controlled processes of drying.

Shrinkage: - The reduction in dimensions of timber which takes place during drying.

Tenon: - A tongue like projection on the end of a piece of timber two fit into a corresponding mortise.

Texture: - Term to indicate relative size and distribution of wood elements.

Veneer: - A thin sheet of wood of uniform thickness obtained by slicing rotary cutting or sawing.

Wound: - An injury inflicted upon the growing tree which has subsequently healed or occluded.

Yield stress: - The lowest stress at which an extension of the test piece increases without increases of load.

FOR GLASS
Sheet glass: Transparent, flats glass having glossy, fire-finished, apparently plane and smooth surfaces, but having a characteristic waviness of surface.

Crush: A lightly pitted is resulting in a dull grey appearance over the region.

Digs: Deep short scratches.

Dirt: A small particle of foreign matter embedded in the glass surface.

Ream: Inclusion within the glass or layers or strings of glass which are not homogenous with the main body of the glass.

Scratches: Any marking or tearing of the surface producing a frosted appearing as though it were done by a sharp or rough instrument.

Smoke: Streaked areas appearing as slight discoloration.

Strings: Transparent lines appearing in though a thread of glass had been incorporated into the sheet.

Wave: Defect resulting from irregularities of the surfaces of glass making objects viewed its varying angles appear wavy or bent.

Clerestorey Windows: These windows are provided near the top of main roof as shown in fig. 8.2 The provide ventilation to the inside of the room as the front is blocked by the verandah. They also improve the appearance of building. The care should be taken to see that the upper part opens inside and the lower part opens outside. Otherwise the rain water will accumulate in the room.

Fig. 8.2

Louver: This is a piece of timber which is fixed in an inclined position within the frame.

Frame: This consists of a group of members which form a support for a door or a window.

Style: This is the outside vertical member for the shutter of a door or a window.
Head: The top or uppermost horizontal part of a frame is known as the head.
Sill: The lowermost or bottom horizontal part of a window frame is known as the sill. The door frames are usually not provided with the sills.
Top rail: This is the topmost horizontal member of the shutter.
Lock rail: This is the middle horizontal member of the shutter where the locking arrangement is provided.
Bottom rail: This is the lowermost horizontal member of the shutter.
Intermediate or cross-rails: The additional horizontal rails fixed between the top and bottom rails of a shutter are known as the intermediate or cross-rails. A rail which is fixed between the top rail and lock rail is called the frieze rail.
Panel: This is the area of shutter enclosed between the adjacent rails.
Holdfast: This is generally in the form of a mild steel flat bar of section 30mm x 6mm and of length 200 mm. The three numbers of such holdfasts are provided on each side of the door frame and two numbers of such holdfasts are provided on each side of the window frame. They keep the frame in position.
Horn: This is a horizontal projection of head or sill beyond the face of the frame. It facilitates the fixing of the frame on the wall opening and its length is about 100 mm to 150 mm.
Shutter: The entire assembly of styles, panels and rails is known as the shutter.
Sash: This is a special type of frame, made of light sections and designed to carry glass. A sash consists of two vertical styles, a top rail and a bottom rail. A sash can be divided vertically or horizontally by providing bars. These bars are known as the sash bars of glazing bars.
Transom: This is a horizontal member which is employed to sub-divide a window opening horizontally.
Jamb: The vertical wall face of an opening which supports the frame of door and window is known as the jamb.
Reveal: The external jamb of a door or a window opening at right angles to the wall face is known as the reveal.
Rebate: The depression or recess made inside the door frame to receive the door shutter is known as the rebate.
Putty: This is a mixture of linseed oil and whiting chalk. It is used for fixing glass panels.

8.1 TIMBER
The timber shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks and shall be graded as first grade and second grade on the basis of the permissible defects in the timber as per table given below:-

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Defects</th>
<th>First Grade</th>
<th>Second Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Cross-grain</td>
<td>Not steeper than 1 in 15</td>
<td>Not steeper than 1 in 10</td>
</tr>
<tr>
<td>(ii)</td>
<td>Sound knots and live knots</td>
<td>(i) Stiles and Rails (a) Short Exposed Face: Not more than 15 mm size and not more than 1 knot/meter (b) Long Exposed Face: Not more than 15 mm size and not more than 1 knot/m. No knot shall occur within 20 mm of the edges (ii) Panels - Not more than 20 mm size and not more than 2 knots/m². No knot shall occur on edge of any component of a Panel.</td>
<td>(i) Stiles and rails (a) Short exposed Face - Not more than 15 mm size and not more than 3 knots per stile and 1 knot per rail (b) Long Exposed Face - Not more than 20 mm size and not more than 3 knots per stile and 1 knot per rail (ii) Panels - Not more than 20 mm size and not more the 4 knot/m². No knots shall occur on edge of any component of a panel.</td>
</tr>
<tr>
<td>S. No.</td>
<td>Defects</td>
<td>First Grade</td>
<td>Second Grade</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>(iii)</td>
<td>Dead and loose knots (plugged)</td>
<td>(i) Stills and Rails - Not more than 10 mm size, centrally located and not more than 1 knot / m</td>
<td>(i) Stiles and Rails - Not more than 10 mm size, centrally located and not more than 3 knots per stile and 1 knot per rail.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Panels - Not more than 15 mm size and not more than 2 knots/m². No knot shall occur on edges of any component of a panel.</td>
<td>(ii) Panels - Not more than 15 mm size and not more than 4 knots/m². No knot shall occur on edge of any component of a panel.</td>
</tr>
<tr>
<td>(iv)</td>
<td>Pitch pockets or streaks</td>
<td>None</td>
<td>Permissible except on exposed edges provided that they are clean and filled up with suitable putty or filler when pitch pockets or streaks are located on the exposed edges of the core, they shall be cut out and filled with piece of wood of similar species with grain running in the same direction. The piece shall be well glued.</td>
</tr>
<tr>
<td>(V)</td>
<td>Sapwood</td>
<td>Total not exceeding 5 mm wide and 150 mm long per meter. (This restriction applies only to super group species).</td>
<td>Total not exceeding 10 mm wide and 300 mm long per meter. (This restriction applies only to super group species).</td>
</tr>
<tr>
<td>(vi)</td>
<td>Pin holes</td>
<td>Permitted provided they are not in cluster</td>
<td>Permitted.</td>
</tr>
<tr>
<td>(vii)</td>
<td>Worm holes</td>
<td>None</td>
<td>Permitted provided they are not more than 10 mm in diameter and not more than one per meter and provided such worm holes are plugged with similar timber in such a manner that the plunging merges with the surrounding area both as to colour and grain.</td>
</tr>
</tbody>
</table>

Note:
(i) Dead and loose knots are permitted only if they are suitably plugged.
(ii) Knot shall not occur where hinges or locks are to be fixed.

### 8.1.2 TIMBER MOST COMMONLY AVAILABLE FOR CONSTRUCTIONAL PURPOSES IN CENTRAL ZONE (M.P.) AS PER IS : 399

<table>
<thead>
<tr>
<th>Standard Trade Name</th>
<th>Abbreviated Symbol</th>
<th>Local Names</th>
<th>Durability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babul</td>
<td>BAB</td>
<td>babul</td>
<td>Low</td>
</tr>
<tr>
<td>Khair</td>
<td>KHA</td>
<td>khair</td>
<td>High</td>
</tr>
<tr>
<td>lendi</td>
<td>LEN</td>
<td>Lendia senha, Kaliasaja, Lendia</td>
<td>Low</td>
</tr>
<tr>
<td>Jhingan</td>
<td>JHI</td>
<td>moyen, moyal moven</td>
<td>Low</td>
</tr>
<tr>
<td>mahua</td>
<td>MAU</td>
<td>mahuwa</td>
<td>High</td>
</tr>
<tr>
<td>bijasal</td>
<td>BIJ</td>
<td>bija</td>
<td>High</td>
</tr>
<tr>
<td>sal</td>
<td>SAL</td>
<td>sal</td>
<td>High</td>
</tr>
</tbody>
</table>
### 8.1.3 Teak wood shall be of three grades, namely, superior, first and second. The other three classes of wood shall be sub-divided into two grades, namely, first and second. Teak, deodar, and non-coniferous timbers other than teak are suitable for door frames in permanent or temporary structure, while coniferous timbers other than deodar are suitable for temporary structures only.

### 8.1.4 Sal Wood is about 30 per cent heavier than teak, 50 per cent harder and about 20 to 30 per cent stronger. In shock resistance it is about 45 per cent above teak. Usually remains immune to attack by white ants and fungi for a long period. Well dried also is not a really easy wood to saw and work. It is a rough constructional wood used for a variety of purposes such as beams, rafters, flooring, piles, bridging.

### 8.1.5 Babul and Khair Woods. These are very strong, hard and rough timbers. Somewhat difficult to saw and machine but finish and polish well.

### 8.1.6 Haldu. Is a fairly hard and strong wood, about 10 per cent harder than teak. It is a very easy wood to saw and machine and finishes very easily and takes strain and polish well. It cannot be dovetailed because it breaks away. Commonly used for door and window frames, floor boards, panelling, etc.

### 8.1.7 Preservation of Timber

The Preservation treatment gives a protection against deterioration due to attacks by fungi, termites, borers and marine organism’s. The timber shall be sawn and seasoned before preservative treatment. If the timber is not required to be polished or painted, an oil type preservative treatment shall be used. After treatment all the exposed surfaces shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401 in a plant approved by the Engineer-in-Charge.

### 8.2 PANELLING MATERIAL

#### 8.2.1 Timber

(a) Timber panels shall be made of larger width.

(b) The minimum width and thickness of a panel shall be 150 mm and 15 mm respectively.

(c) When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels.

(d) The grains of timber panels shall run along the longer dimensions of the panels, and no single panel exceeds 0.5 square meters in area.

#### 8.2.2 Plywood /Plywood Boards

(a) Plywood is made by cementing or glueing together three or more layers of thin sheets of wood (called veneers) into panels, usually with the grains of adjacent sheets running at right angles to each other. Plywood shall be of BWP grade or BWR grade as per IS 303.

(b) **Adhesive:** For bonding adhesive shall be BWP type synthetic resins conforming to IS 848.

(c) The thickness of all veneers shall be uniform, within a tolerance of ± 5%. Corresponding veneers on either side of the centre one shall be of the same thickness and species. The requirements of thickness and core veneers shall be as follows;

(i) In 3 ply board’s upto 5 mm thick. The combined thickness of the face veneers shall not exceed twice the thickness of centre ply.

(ii) In multiply boards, the thickness of any veneer shall not be more than thrice the thickness of any
other veneer.

(iii) The sum of the thickness of the veneers in one direction shall approximate to the sum of the thickness of the veneers at right angle to them and shall not be greater than 1.5 times this sum except for 3 ply as specified in (i) above.

(d) Thickness Thickness ranging from 3 to 25 mm of ply wood boards are available. Tolerance in thickness shall be ± 10% for board's upto and including 5 mm; ± 7% for boards from 6 to 9 mm and ± 5% for boards above 9 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plays in plywood boards shall be as per table below: -

<table>
<thead>
<tr>
<th>Thickness in mm</th>
<th>No. of ply</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,4,5,6</td>
<td>3</td>
</tr>
<tr>
<td>5,6,8,9</td>
<td>5</td>
</tr>
<tr>
<td>9,12,15,16</td>
<td>7</td>
</tr>
<tr>
<td>12,15,16,19</td>
<td>9</td>
</tr>
<tr>
<td>19,22,25</td>
<td>11</td>
</tr>
<tr>
<td>(Above 11 Ply as ordered)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Plywood of 9 mm thick of 5 or 7 ply may be used generally.

(e) When tested moisture content of the plywood boards shall not be less than 5% and not more than 15%. In accordance with IS 1734 (Part 1)

(f) Testing: Testing of one sample for every 100 sqm or part thereof shall be done as per IS 303. However, testing may not be done if the total requirement of plywood boards is less than 30 sqm.

8.2.3 Particle Boards
(a) Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocelluloses i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-1 as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

(b) Adhesives: shall be as specified in para 8.2.2.b. above

(c) Thickness and Tolerance: Thickness of particle boards shall be as specified. Tolerance in thickness shall be ± 5% for board's upto and including 25 mm thick and ± 2.5% for boards above 25 mm thickness. Each board shall be of uniform thickness.

(d) Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3087. However, testing may not be done if the total requirement of particle boards in a work is less than 30 sqm.

8.2.4 Veneered Particle Boards:
(a) Veneered Particle Boards with core of FPT-1 or graded board Grade-1 particle board (IS 3087) with commercial or general purpose veneer (Type-1) or decorative veneers on both faces or with decorative veneer on one face and commercial /general purpose veneers on the other Type-2. Face veneers are bonded using adhesives, under the influence of heat and pressure.

(b) Adhesives: The adhesive used for bonding veneers shall be BWP or BWR type conforming to IS 848 for grade I veneered particle board.
(c) **Thickness & Tolerance:** Veneered particle boards are available in various thicknesses 6, 10, 12, 20, 25, 30, 35, 40, 45 & 50 mm. Tolerance in thickness shall be ± 5%.

(d) **Testing:** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3097. However, testing may not be done if the total requirement of veneered particle boards in a work is less than 30 sqm.

8.2.5 Non-Asbestos Fiber Boards

(a) Fiber boards shall be of medium density cement board reinforced with wood fiber, produced by fiber zing steamed wood under pressure, blended with adhesive and wax and formed into solid panels under controlled conditions of heat and pressure as per IS 14862.

(b) **Adhesives:** As per clause above 8.2.2.b.

(c) **Thickness:** Fiber boards are available in thickness 6, 9, 12, 15, 18, 22, 25, 30, 35 & 40 mm. The tolerance in thickness shall be ± 0.3 mm.

8.2.6 Float Glass, Frosted Glass: - The float glass shall conform to IS 14900. It shall be cleared floor transparent free from cracks subject to be allowable defects and should be approved by the Engineer in charge.

8.2.7 Wire Cloth (Wire Gauze): - Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanized mild steel wires in both warp and weft directions. The wire cloth shall be properly selvedge by one or more wires in each edge.

(a) **Mesh:** Average width of aperture and the nominal diameter of the wire shall be as under

<table>
<thead>
<tr>
<th>Average width of Aperture mm</th>
<th>Nominal dia. of wire mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.40</td>
<td>0.63</td>
</tr>
<tr>
<td>1.18</td>
<td>0.56</td>
</tr>
<tr>
<td>1.00</td>
<td>0.50</td>
</tr>
</tbody>
</table>

(b) Width of aperture and dia of wire cloth shall be as specified, unless otherwise stated, wire clothe of 1.40 mm average aperture width woven with 0.63 mm nominal dia galvanized mild steel wire shall be used.

(c) Fly-proof wire cloth (aperture 1.40 mm) is generally provided in Kitchen and dining areas while wire cloth of smaller aperture is used in mosquito proof shutters.

8.2.8 Veneered Decorative Plywood shall be conform to IS 1328 and of grades BWR & MR and shall be of two types. Type 1 and type 2.

(a) Requirement of Type-1 Veneered decorative plywood shall be as under: -
   (i) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.
   (ii) The decorative veneered surface shall be free from torn grain, dead knots discolourisation and sapwood.
   (iii) The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-charge permitted under para 8.2.8. a (i). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.
(b) **Adhesive:** The adhesive for bonding veneers shall be BWR and MR type synthetic resin adhesive conforming to IS 848. For BWR and MR grades veneered decorative plywood respectively.

(c) **Dimensions:**
Plywood boards dimension shall be as follows:-
- 2400 mm x 1200 mm
- 2100 mm x 1200 mm

Thickness shall be 3mm, 4mm, 6mm, 9mm, 12mm, 19mm and 25mm.
- 2100 mm x 900 mm
- 1800 mm x 1200 mm
- 1800 mm x 900 mm

Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

(d) **Tolerances:** Tolerances on the nominal sizes of finished boards shall be as follows:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>+ 6 mm</td>
</tr>
<tr>
<td>Width</td>
<td>+ 3 mm</td>
</tr>
<tr>
<td>Thickness :</td>
<td></td>
</tr>
<tr>
<td>(i) Less than 6 mm</td>
<td>± 10%</td>
</tr>
<tr>
<td>(ii) 6 mm and above</td>
<td>± 5%</td>
</tr>
<tr>
<td>Edge straightness</td>
<td>2 mm per 1000mm or 0.2%</td>
</tr>
<tr>
<td>Squareness</td>
<td>2 mm per 1000mm or 0.2%</td>
</tr>
</tbody>
</table>

Note:– Edge straightness and squareness shall be tested as procedure below

(e) **Finish:** The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested. as per above procedure shall be within the tolerance specified in para 8.2.8.6 above

(f) **Sampling and Criteria for Conformity:** The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

(g) **Tests:** Following tests of boards shall be:

(i) **Moisture content:** Decorative veneered plywood of either type when tested in accordance with IS 1734 (Pt.l) shall have a moisture content not less than 5% and not more than 15%.

(ii) **Water Resistance Test:** Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 ± 2°C for a period of 3 hours and dried for 8 hours at a temperature of 65 ± 2°C and then followed by two more cycles of soaking and drying under same conditions described above, Decorative Veneered plywood of either type shall not show delimitation or blister formation.

(l) **Marking:** On the face of each plywood board near one corner shall be legibly and indelibly marked or stamped with the following.

(a) Batch no. & Year of manufacture
(b) Type of plywood
(c) Criteria for which the plywood has been labeled as ECO mark
(d) Indication of the source of manufacture

The decorative veneered plywood may also be marked with standard BIS certification mark. Act 1986
8.2.9 Prelaminated Particle Boards
The prelaminated particle boards are available in two grades Grade I and II as per IS 12823. Each grade is further classified in four types; Type -I, II, III, IV.

8.2.9.1 Material
(a) Particle Board Prelaminated particle board Grade-1 (FPT-I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and prelaminated conforming to IS 12823 Grade-1, type II or I shall be used.

(b) Impregnated Base Paper: Printed or plain coloured absorbent base paper having a weight of 60 to 140 g/m² impregnated in a suitable synthetic resin and dried to a volatile content of 4 to 8 per cent shall be used for prelamination on both surfaces of particle board.

(c) Impregnate Overlay: An absorbent tissue paper having a weight of 18 to 40 g/m² impregnated in a suitable synthetic resin and dried to volatile content of 4 to 8%.

8.2.9.2 Dimension and Tolerances
(a) Dimensions of prelaminated particle boards shall be as follows:
Length shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1, 1.8, 1.5, 1.2, 1.0 and 0.9 meters.
Width shall be 1.8, 1.5, 1.2, 1.0, 0.9, 0.6 and 0.45 meters.
Thickness shall be 6, 9, 12, 15, 20, 25, 30, 35, 40 and 45 mm.

(b) Tolerances: Tolerances on the nominal sizes of finished boards shall be as given below:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>+ 6 mm</td>
</tr>
<tr>
<td></td>
<td>- 0</td>
</tr>
<tr>
<td>Width</td>
<td>+ 3 mm</td>
</tr>
<tr>
<td></td>
<td>- 0</td>
</tr>
<tr>
<td>Thickness</td>
<td>5 %</td>
</tr>
<tr>
<td>Edge straightness</td>
<td>2 mm per 1000 mm or 0.2 %</td>
</tr>
<tr>
<td>Squareness</td>
<td>2 mm per 1000 mm or 0.2 %</td>
</tr>
</tbody>
</table>

Note: Edge straightness and squareness shall be tested as per IS 12823.

8.2.9.3 Sampling and Inspection: The number of prelaminated particle board to be selected from a lot shall be in accordance with the Table 8.4 given below:

<table>
<thead>
<tr>
<th>Lot Size</th>
<th>Number of prelaminated boards to be selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 50</td>
<td>2</td>
</tr>
<tr>
<td>51 to 100</td>
<td>3.</td>
</tr>
<tr>
<td>101 to 200</td>
<td>4</td>
</tr>
<tr>
<td>201 to 300</td>
<td>5</td>
</tr>
<tr>
<td>301 to 500</td>
<td>7</td>
</tr>
<tr>
<td>501 and above</td>
<td>10</td>
</tr>
</tbody>
</table>

(a) The prelaminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the prelaminated particle boards in the lot may be arranged in a serial order and every rth prelaminated particle board may be selected till the required number is obtained, ‘r’ being the integral part of N/n, where N is the lot size and n is the sample size.

(b) All board selected as given in para 8.2.9.3.a above shall be tested as specified in IS 2380 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 8.2.9.2.b
8.2.9.4 **Testing and Number of Tests:** For each of particle board selected as per para 8.2.9.3. Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

8.2.9.5 **Criteria for Conformity:** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 8.2.9.2 & 8.2.9.4 of this specification. In case of a failure, double sample shall be taken from the lot for testing. The tot shall be considered as passed, if all these samples conform to the specified requirement.

8.2.9.6 **Marking:** Each prelaminated particle board shall be legibly and indelibly marked on any of its edges with following:
(a) Batch number and year of manufacture
(b) Thickness
(c) Grade and type of prelaminated particle board
(d) Indication of source of manufacturer

The prelaminated particle board may also be marked with standard BIS certification marked act 1986.

8.2.10 **Coir Veneer Board for General Purposes**
It shall conform to IS 14842 and it is manufactured with a combination of coconut fiber needled felt, veneer and jute fibers with Kraft paper coconut fiber. Needled felt can be used as core cross bands or as outer skin formed with jute fibers and Kraft paper. However, the composite ply should be a balanced construction on either side of central ply. The blended mass of glued fibers is laid to form a mat which is pre needled. It shall be of two grades:
(i) Boiling water resistant (BWR) grade
(ii) Moisture resistant (MR) grade

(a) **Material**
(i) *Coconut Fiber:* Coconut fiber layer used in the manufacture of coir veneer board shall be uniform with minimum of 600 g/m².
(ii) *Jute:* Jute fiber layer used in the manufacture of coir veneer board shall be uniform with minimum of 60 g/m².
(iii) *Adhesive:* Adhesive for manufacture of coir veneer board shall be conforming to BWR/MR of IS 848 for BWR/MR grade boards respectively.
(iv) *Veneer:* Any species of timber may be used for the manufacture of veneers.
(v) *Kraft Paper:* Kraft paper used in manufacture of coir veneer board shall be uniform with minimum of 40 g/m².

(b) **Permissible Defects:** Gap in cores and cross band shall not be permitted. Splits in cores and cross bands may be permitted to an extent of 2 per core or cross band and overlap shall be permitted in core/cross bands only,

(c) **The Dimensions and Tolerances:** The dimensions and tolerances shall be as per IS 12049. The dimensions and tolerances of coir veneer board shall be quoted in following order. The first dimension shall represent the length, second the width and the third thickness. The thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 9 mm, 12 mm, 16 mm, 18 mm, 20 mm and 25 mm. The following tolerance on nominal thickness shall be permissible.
(i) Less than 6 mm  ± 10%
(ii) 6 mm and above  ± 5%

(d) **Workmanship and Finish:** Coir veneer board shall be of uniform thickness and density throughout the length and width of board. The square ness and edge straightness of the board shall be as per IS 12842 and below procedure:

(f) **Sampling:** The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.
(g) Tests: The tests shall be carried out as specified in IS 14842:

(h) Moisture Content: Coir veneer board when tested in accordance with IS 3734 (Part I) shall have a moisture content not less than 5% and not more than 15%

(i) Marking: Each coir veneer board shall be legibly and indelibly marked or stamped with the following near one corner:

1. Batch no. & Year of manufacturing
2. Identification of source
3. The grade and type as follows: - (i) Boiling water resistant (BWR) and (ii) Moisture resistant (MR)
4. Standard mark by BIS act 1986

8.2.11 Marine Plywood
Marine plywood shall be generally conforming to IS 710. Selection on timber species for manufacture of plywood shall be as prescribed in IS 710 and as far as possible a single species of timber shall be used.

(a) Adhesive: The adhesive used for bonding the veneer shall be of the hot press synthetic resin, phenol formaldehyde type (BWP) and shall conform to IS 848. Extender shall not be added to the adhesive by the plywood manufacturers. Fillers, if used, shall not exceed 10% by mass of solid content of the glue.

(b) Dimensions and thickness
Dimensions and thickness shall be as specified in para 8.2.10.c.

(c) Tolerances: The following tolerances in the nominal size of finished boards shall be permitted:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Nominal Size</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>Upto 120cm.</td>
<td>+ 3 mm</td>
</tr>
<tr>
<td></td>
<td>Above 120cm.</td>
<td>+ 6 mm</td>
</tr>
<tr>
<td>Width</td>
<td>Upto 90 cm.</td>
<td>+ 3 mm</td>
</tr>
<tr>
<td></td>
<td>Above 90 cm</td>
<td>+ 6 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>Upto 4 mm</td>
<td>± 10 %</td>
</tr>
<tr>
<td></td>
<td>Above 4 mm</td>
<td>± 5 %</td>
</tr>
</tbody>
</table>

(d) Sampling and test: The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638. Test pieces cut from each board shall be subjected to test as specified in IS 710.

1. Moisture content
2. Glue adhesive in dry state
4. Tensile strength
5. Mycological test
6. Retention of preservative

(e) Marking: Each plywood board shall be legibly and indelibly marked or stamped with following particulars along with such other marks as the purchaser may stipulate at the time of placing order:

1. Batch number & Year of manufacturing.
2. Manufacturer’s name and recognized trade mark.
3. Abbreviation indicating the specie of timber used in each ply as indicated in col. 3 of Table 1 & 2 of IS 710.

8.2.12 Fire Retardant Plywood
(a) Fire retardant plywood shall generally conform to IS 5509. The plywood to be given fire retardant treatment shall conform to BWR grade of IS 303 to be able to stand pressure impregnation. Plywood for treatment shall be clean, free from oil or dirt patches on the surface and at a moisture content not exceeding
15%. In case of veneered decorative plywood care shall be taken that colour of the solution does not spoil to decorative surface. For Eco-mark the plywood shall conform to the requirements of Eco-mark specified in IS 303.

(b) Fire Retardant Treatment: This shall be either pressure impregnation or soaking treatment as per IS 5509.

(c) Choice of Treatment: The choice of treatment may be left to the manufacturer of plywood as per fire resistant requirements prescribed in IS 5509. The purchaser should however, specify whether plywood is to be treated with fire retardants only or with fire retardants and preservatives. The recommended retention of fire retardant chemicals for different hazards like interior or exterior use not subject to leaching by rain and water is of the order of 50 kg/m³.

(d) Conditioning after Treatment: The plywood after treatment shall be conditioned to suitable equilibrium moisture content of not more than 20%.

(e) Dimension and Tolerances shall conform to IS 12049. The tolerance of thickness shall conform to IS 303.

(f) Sampling: The method of drawing representative sample and the criteria of conformity shall be as prescribed in IS 7638. The following test specimens shall be cut from portions 150 mm away from the edges for tests specified as under;
1. For Flammability: Six test specimens 125 mm x 125 mm in full thickness of material from each sample.
2. For Flame Penetration: Three test specimens 125 mm x 125 mm in full thickness of material from each sample.
3. For Rate of Burning: Three test specimen 100 mm x 12.5 mm in full thickness of material from each sample.

(g) Test Requirements and Other Tests
(i) Moisture Content: Shall not exceed 20%.
(ii) Flammability: When tested as per IS 1734, time taken for second ignition shall not be less than 30 minutes.
(iii) Flame Penetration: When tested as per IS 1734, time taken for flame penetration shall not be less than 15 minutes for every 6 mm thickness.
(iv) Rate of Burning: When tested as per IS 1734, the time taken to lose weight from 30% to 70% shall not be less than 20 minutes.

(h) Marking: Each board shall be legibly and indelibly marked near the edge with the following:
1. Manufacturer's name and Year of manufacture his initials
2. Type of treatment
3. Criteria for which the plywood has been labeled as ECO mark.
4. Each board may also be marked with standard mark governed by the BIS Act, 1986.

8.2.13 Decorative Thermosetting Synthetic Resin Bonded Laminated Sheets
These sheets shall generally conform to IS 2046. This material is intended for interior use and is not intended for load bearing applications.

(a) Types: The material shall be of two types:-
1. Type 1- Having only one side bearing decorative surface the other side being roughened or given an appropriate treatment to promote adhesion to the base. This type shall generally be used and, unless otherwise specified.
2. Type 2- Having both sides bearing the decorative surface, the two sides may be different in colour or pattern or both.
(b) Requirements
(i) Appearance: The types of surface finish of decorative and reverse side, edge finish, colour and pattern shall be as agreed to between the purchaser and the supplier. The sheets shall be reasonably free from local deformation.

Note: Since sheets may vary slightly in colour and appearance, it is recommended that sheets for any one scheme may be matched.

(ii) Flatness: For nominal thickness 1.5 mm when a sheet is tested for flatness in accordance with the method given in Appendix C of IS 2046, the height above the flat surface at the edge of full manufactured and trimmed width shall no where exceed 150 mm.

(iii) Tolerance to nominal thickness: The departure from nominal thickness of sheet at any point shall not exceed the value given below:

<table>
<thead>
<tr>
<th>Nominal Thickness</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 1.5mm</td>
<td>±0.25 mm</td>
</tr>
</tbody>
</table>

(iv) Straightness of edges of rectangular finished panels, resistance to dry heat, resistance to boiling water, resistance to staining, gross breaking strength, packing and marking, sampling and criteria for conformity etc. shall be as per IS 2046.

8.3 DOOR, WINDOW AND VENTILATOR FRAMES -

Purpose: The main function of doors in a building is to serve as a connecting link between the various internal parts. The number of doors in a room should be kept minimum due to the fact that more number of doors will cause obstruction and reduce the effective usable carpet area of the room. The windows are generally provided to give light and ventilation both to the interior parts of building. When windows are provided for the purpose of light only, as in case of storage rooms, show rooms, etc. they may be fixed so that they cannot be opened. But when the windows are provided for light and ventilation, some or all the portion of windows must open. This can be achieved by providing suitable hinges at top, bottom or sides.

8.3.1 Timber for door, window & ventilator: Timber frame for door, window and ventilators shall be as specified and, shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without any warp or bow.

8.3.1.1 Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn.

8.3.1.2 Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters.

8.3.1.3 In frames a tolerance of ± 2 mm shall be permitted in the specified finished dimensions of timber sections.

8.3.2 Joints
(a) The Jamb posts shall be through tenoned in to the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling.

(b) The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS 4835 or adhesive conforming IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins.

(c) The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled door frame shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.
8.3.3 Fixing of Frames
(a) Before fixing a position the frames shall be got approved by the Engineer-in-Charge.
(b) The surface of the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar.
(c) Frames shall be fixed to the abutting masonry or concrete with holdfasts or metallic fasteners as specified. After fixing the jamb posts of the frames shall be plugged suitably and finished neat.
(d) Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be suitably strutted and wedged in order to prevent warping during construction.
(e) A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames.
(f) In case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

8.3.3(a) The frame work for False ceiling and partition frame also shall be done on above specification.

8.3.4 Measurements
(a) Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension. However, in case of members having moulding, rounding or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut.
(b) Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of upto three places of decimal.

8.3.5 Rate
The rate shall include the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

8.4 TRUSSES
(a) The trusses work shall be carried out as per detailed drawings with specified timber and as per direction of the Engineer-in-Charge. Sawing shall be truly straight and square, and in the direction of the grains.

(b) The scantlings shall be accurately planed smooth to the full dimensions and rebate rounding and moulding shown in the drawings, before the same are framed. Patching or plugging of any kind shall not be permitted. A tolerance of +3 mm and -2 mm shall be allowed in the finished cross sectional dimension.

8.4.1 Joints
(a) The joints shall be as per detailed drawings and shall be strong, simple and neat. All mortise and tenon joints, mitered joints, scarf's etc. shall fit in fully and accurately without wedging or fillings. Holes of correct sizes shall be drilled before inserting screws/bolts.

(b) Driving in screws with hammer is prohibited. The screws, bolts and nails shall be dipped in oil before using; the heads of nails and screws shall be sunk and puttied. The gauge and length of nails, screws and bolts shall be approved by the Engineer-in-Charge before using on works.
8.4.2 Shaping Form and Cutting
(a) The wood sections, as specified or required, shall be straightened, cut square and to correct lengths.

(b) A fine accuracy shall be ensured in the fabrication of various member so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true to shape and free from twist, kinks, buckles or open joints.

8.4.3 Fabrication
(a) As per drawing, a full size truss diagram shall first be drawn on a leveled platform. From this full size diagram, templates of all joints as for tenons, mortises, scarves etc. shall be made for use in the fabrication. The template shall be made to correspond to each member and plate holes for screws and bolts shall be marked accurately on them and drilled.

(b) The templates shall be laid on wooden members and the holes for screwing and bolting marked on them. The ends of the wooden members shall also be marked for cutting. The base of columns and the position of anchor bolts shall be carefully set out.

(c) Before fabrication of the truss individual members shall be assembled together to ensure close abutting or lapping of the surfaces of the different members and fitted close together as per drawing.

8.4.4 Hoisting and Placing in Position
(a) The trusses shall be hoisted and placed in position carefully, without any damage to itself and other building work and injury to workman. The trusses shall be secured to walls by means of holding down bolts or as per direction of the Engineer-in-Charge.

(b) The necessary mechanical appliances such as lifting tackle winch etc. for hoisting the truss shall be used. The trusses shall be stayed temporarily till they are permanently secured in position and connected with each other by means of purlins. Holding down bolts cleats used for purlins and bottom plates used for tie and rafter member shall be paid for separately.

8.4.5 Surface Treatment
(a) Wood work shall not be painted, oiled or otherwise treated before it has been approved by the Engineer-in-Charge.

(b) All portions of timber built into or against or close to masonry or concrete or hurried in ground shall be given two coats of boiling coal tar. All junctions of rafters, purlins, beams and wall plates shall be painted with approved wood primer.

8.4.6 Measurements
(a) Wood work shall be measured for finished dimensions. No allowance shall be made for dimensions supplied beyond those specified. Length of each piece shall be measured over all nearest to a cm. so as to induce projections for tenons, scarves or miters.

(b) Width and thickness shall be measured to the nearest mm. Cubical contents can be worked out in units cubic meters upto 3 places of decimal in whole numbers.

8.4.7 Rate
The rate includes the cost of materials and labour involved in all the operations described above. Unless otherwise specified, iron fixtures such as bolts and nuts, M.S. steel plates, holding down bolts and staining, priming, painting or polishing of the work shall be paid for separately.

8.5 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS (FIG. 8.2)
Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the
drawings or as directed by the Engineer-in-Charge.

Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm for door shutter and 1 mm for window and ventilator shutters the right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than 3 mm. Generally Panelled glazed or Panelled and glazed shutter shall conform to IS 1003.

8.5.1 Frame Work
8.5.1.1 Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or hunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles.

The bottom rails shall have double tenon Joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified.

The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

8.5.1.2 Gluing of Joints : The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and amino plastic) conforming to IS 848 or polyvinyl acetate dispersion based adhesive conforming to IS 4835 and pinned with 10 mm dia hardwood dowels or bamboo pins or star shaped metal pins; after the frames are put together and pressed in position by means of press.

8.5.1.3 Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be of one or more pieces of timber.

The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

8.5.1.4 Door Shutters
(a) Finished dimensions and tolerances of components of door shutters have been given in Table below.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Width mm</th>
<th>Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Vertical Stile, top and freeze rail</td>
<td>100±3</td>
<td>35 ±1</td>
</tr>
<tr>
<td>(b)</td>
<td>Lock rail</td>
<td>50 ±3</td>
<td>35 ±1</td>
</tr>
<tr>
<td>(c)</td>
<td>Bottom rail</td>
<td>200±3</td>
<td>35 ±1</td>
</tr>
<tr>
<td>(d)</td>
<td>Muntin</td>
<td>100±3</td>
<td>35 ±1</td>
</tr>
<tr>
<td>(e)</td>
<td>Glazing bar</td>
<td>40±3</td>
<td>35 ±1</td>
</tr>
</tbody>
</table>
(b) **Size and Types:** Size and types of the timber panels and glazed shutters shall generally conform to modular sizes specified in Table 8.6 below.

### TABLE 8.6
Dimension of Door Shutters

<table>
<thead>
<tr>
<th>S/. No.</th>
<th>Designation of Doors</th>
<th>Width mm</th>
<th>Height mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>8 DS 20</td>
<td>700</td>
<td>1905 (1945)</td>
</tr>
<tr>
<td>(ii)</td>
<td>8 DS 21</td>
<td>700</td>
<td>2005 (2045)</td>
</tr>
<tr>
<td>(iii)</td>
<td>9 DS 20</td>
<td>800</td>
<td>1905 (1945)</td>
</tr>
<tr>
<td>(iv)</td>
<td>9 DS 21</td>
<td>800</td>
<td>2005 (2045)</td>
</tr>
<tr>
<td>(v)</td>
<td>10 DS 20</td>
<td>900</td>
<td>1905 (1945)</td>
</tr>
<tr>
<td>(vi)</td>
<td>10 DS 21</td>
<td>900</td>
<td>2005 (2045)</td>
</tr>
<tr>
<td>(vii)</td>
<td>12 DT 20</td>
<td>1100</td>
<td>1905 (1945)</td>
</tr>
<tr>
<td>(viii)</td>
<td>12 DT 21</td>
<td>1100</td>
<td>2005 (2045)</td>
</tr>
</tbody>
</table>

**Notes:**

1. The designation refers to modular sizes of door openings. First number stands for width and the last for height in modules (M = 100 mm). Alphabet D refers to doors, ‘S’ to single and T to double leaf shutter. For instance, the designation 9 DS 20 denotes a door opening having width equal to 9 modules i.e. 900 mm and height equal to 20 modules i.e. 2000 mm. The door is with single shutter. In a similar way, the designation 12 DT 20 denotes a door opening having width equal to 12 modules i.e. 1200 mm and height equal to 20 modules i.e. 2000 mm. The door is of two shutters.

2. Standard sizes of door frames are covered in IS 4021 and IS 4351.

3. The standard widths and heights for panel doors are arrived at as IS 1003 (Pt. 1). In case the modular height is taken on the finished floor level, the height of the door shall be the one given in bracket. In the case of double leave shutters, the rebate in the shutter shall be as given in IS 1003 (Part-1).

8.5.1.5 **Window and Ventilator Shutters:** Window and ventilator shutters shall conform to IS 1003 (Part 2).

(a) **Dimensional Sizes and Tolerances:** The finished dimensions and tolerances of different component shall be as given in Table 8.7.

### TABLE 8.7
Dimensions and Tolerances of Components of Window and Ventilator Shutters

<table>
<thead>
<tr>
<th>Description of components</th>
<th>Window Shutters</th>
<th>Ventilator Shutters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width mm</td>
<td>Thickness mm</td>
</tr>
<tr>
<td>Stiles and rails</td>
<td>80 ±3</td>
<td>25 ±1</td>
</tr>
<tr>
<td></td>
<td>30 ±1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muting</td>
<td>60 ±3</td>
<td>25 ±1</td>
</tr>
<tr>
<td></td>
<td>30 ±1</td>
<td></td>
</tr>
<tr>
<td>Glazing bars</td>
<td>40 ±1</td>
<td>25 ±1</td>
</tr>
<tr>
<td></td>
<td>30 ±1</td>
<td></td>
</tr>
</tbody>
</table>

(b) **Designation:** Window and ventilator shutters shall be designated by symbols denoting the width, type and height of window and ventilators in following manner.
(i) **Width**: It shall be indicated by the number of modules in the width of opening.

(ii) It shall be indicated by the following letters of alphabet: W-window, V-Ventilator, S-Single shutter, T-Double shutter.

(iii) **Height**: It shall be indicted by the number of modules in the height of opening.

**Example**: 10 WT 12 would mean a window shutter suitable for a double shutter window of 10 modules width and 12 modules height. 12 V 6 would mean ventilator shutter suitable for a ventilator of 12 modules width and 6 modules height.

(c) **Sizes**: Sizes of window and ventilator shutters shall generally conform to the modular sizes specified in Tables 8.8. These sizes are derived after allowing the thickness of the frame and a margin of 5 mm all round based on 100 mm module.

(d) **Tolerances on the overall dimensions of window and ventilator shutter shall be ± 3 mm.**

### TABLE 8.8
Dimensions of Timber Window and ventilator Shutters

<table>
<thead>
<tr>
<th>Designation</th>
<th>Width mm</th>
<th>Height mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 WS12 (Window)</td>
<td>500</td>
<td>1100</td>
</tr>
<tr>
<td>10 WT12 &quot;</td>
<td>460</td>
<td>1100</td>
</tr>
<tr>
<td>12 WT12 &quot;</td>
<td>560</td>
<td>1100</td>
</tr>
<tr>
<td>6 WS13 &quot;</td>
<td>500</td>
<td>1200</td>
</tr>
<tr>
<td>10 WT13. &quot;</td>
<td>460</td>
<td>1200</td>
</tr>
<tr>
<td>12 WT13 &quot;</td>
<td>560</td>
<td>1200</td>
</tr>
<tr>
<td>6V6 (Ventilator)</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>10V6 &quot;</td>
<td>900</td>
<td>500</td>
</tr>
<tr>
<td>12V6 &quot;</td>
<td>1100</td>
<td>500</td>
</tr>
</tbody>
</table>

8.5.2 **Mounting and glazing bars**: Where required shall be stubtenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm whichever is less. Unless otherwise specified the finished dimensions of the components of frame work of shutters shall be as given in Table 8.7.

8.5.2.1 The tolerance on width of styles and rail shall be ± 3 mm. The tolerance in thickness will be ± 1 mm. The thickness of all components of frame work shall be the same as the thickness of the shutter. Tolerance on over all dimensions of the shutter shall be ± 3 mm.

8.5.3 **Rebating**

The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the Engineer-in-Charge. In case of double leaved shutters, the meeting of the stiles shall be rebated by one-third the thickness of the shutter. The rebating shall be either splayed or square type as shown in Fig. 8.3 given below.

Drawing not to Scale
All dimensions are in mm
8.5.4 Paneling

(1) The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, and particle board panels as given in para 8.2 of this sub head and shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove.

(2) Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

(a) Timber Panels: Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square meters in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.
(b) **Plywood Panels:** Plywood boards used for paneling of shutters shall be BWP type or grade as specified in 8.2.2. Each panel shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm thickness for single panel construction unless otherwise specified.

(c) **Veneered Particle Board Panels:** Veneered Particle board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified in 8.2.4. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

(d) **Fiber Board Panels:** Fiber board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive each fiber board panel shall be a single piece unless otherwise specified.

(e) **Wire Gauze Panels:** Wire Gauze used for paneling of shutters shall be woven with 0.63 mm dia galvanized mild steel wire to form average aperture size of 1.40 mm as specified in 8.2.7. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shaft be fixed. The space "between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be a single piece, and the panels shall be so designed that no single panels exceeds 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauze, of panel by providing and fixing 20 x 20 mm square or equivalent beading to the external face to the required patterns as decided by the Engineer-in-Charge.

(f) **Glass Panels:** Glass paneling (Glazing) shall be done as specified in 8.2.6. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. Frosted glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

(g) Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 liter of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

(h) **Finish:** Panels of shutters shall be flat and well sanded to a smooth and level surface.

8.5.5 Beading
Beadings in Panelled shutter shall be provided where specified in architectural drawings or directed by the Engineer-in-Charge. Each length of beading shall be single piece. Joints at the corners shall be mitered and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

8.5.6 Machine/Factory made Shutters
Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without any priming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

8.5.7 Fixing of Shutters
(a) **Side hung shutters:** For side hung shutters of height upto 1.2 m, each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m, each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters.

(b) **Top hung and bottom hung shutters:** shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap.
(c) Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used.

(d) For shutter of more than 40 mm thickness butt hinges of size 125 x 90 x 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

8.5.8 Fittings
Fittings shall be provided as per schedule of fittings decided by Engineer-in-Charge, and as per schedule (given for guidance) shall be as given below. Cost of providing and fixing shutter shall include cost of hinges and necessary screws for fixing the same. All other fittings shall be paid for separately. The fittings shall conform to specifications laid down in para 8.13.

SCHEDULE OF FITTING FOR DOORS AND WINDOWS

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of Fittings</th>
<th>Single leaf door shutters external or glazed</th>
<th>Double leaf door shutters, panelled or glazed</th>
<th>Single leaf door shutters inter communicating panelled or glazed</th>
<th>Single leaf wire gauze door shutters</th>
<th>Single leaf wardrobe // cup-board shutters</th>
<th>Single Seat window shutters Panelled or glazed</th>
<th>Fan light/ clear storey window shutters</th>
<th>Designation no. of wood screw</th>
<th>Length in mm of wood screws</th>
<th>IS 6760</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Butt Hinges 100 mm</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>40</td>
<td>For fixing wooden cleat</td>
</tr>
<tr>
<td>2.</td>
<td>Butt Hinges 75 mm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Butt Hinges 50 mm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Piano Hinges</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Tower Bolt 250 mm</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>30</td>
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<tr>
<td>6.</td>
<td>Tower Bolt 150</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Tower Bolt 100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Sliding door Bolt 300mm</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>35</td>
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</tr>
<tr>
<td>9.</td>
<td>Sliding door Bolt 250mm</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>35</td>
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<tr>
<td>10.</td>
<td>Floor door stopper</td>
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<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
<td>30</td>
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</tr>
<tr>
<td>11.</td>
<td>Door handle with plate 100mm</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>25</td>
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<tr>
<td>12.</td>
<td>Window handle with plate 75 mm</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Casement stay 300 mm</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Helical door spring (Superior quality)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Cupboard / Wardrobe Lock</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Fanlight Catch</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>8</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note for - Door Shutters

Door of room adjoining the verandah, corridor, lobby or hall, shall be considered as external door. Where the height of the door leaf exceeds 2.15 meters above the floor level, one extra hinge shall be provided for every additional height of 0.50 meter, or part thereof and the length of top bolts shall be increased by the height of the leaf above 2.15 meters from floor level. Single leaf door shutters of more than 0.80 m in width shall be provided with one extra hinge. Fan light shutters of more than 0.80 meters width shall be provided with one extra hinge and extra quadrant stay. In double leaf shutters of doors, two door bolts shall be fixed to the first shutter and one to the closing shutter at the top. In case of single leaf inter communicating, Panelled glazed or paneled door shutter for bath and W.C. one tower bolts will be replaced by a bathroom latch. For shutter exceeding 40 mm thickness, heavy type M.S. butt hinges of 125 x 90 x 4 mm shall be used. In case of external door shutters, instead of sliding door ball mort ice lock can be provided where specified. Cupboard and wardrobe shutters will have ball catches where specified. Finger plates shall be provided in case of bath and WC shutters in office buildings.

Note for - Window Shutters

In case of windows with double shutters, two tower bolts shall be fixed to the closing shutters and one tower bolt to the first shutter at the top. In case of window shutters, hooks and eyes may be provided in lieu of casement stays where specified. Where the height of window shutter exceeds 1:20 meters one extra hinge shall be provided and length of top bolts shall be increased by height of the leaf above 2.15 meters from the floor level. Window shutter with steel frames shall be provided with six hinges in case of double leaf shutters and three hinges in case of single leaf shutters, irrespective of height and width of shutters.

Note for - Fanlight and Clerestory Window or Ventilator

Centrally hung and bottom hung CS windows and fan lights, will be provided with chain and hook bamboo pole with hook for opening ventilators shall be provided for each residence or for set of 4 rooms in case or office building. Centrally hung clerestory windows or fan lights will have fan light pivots in lieu of hinges.

8.5.9 Wooden Cleats and Blocks

Wooden cleats and blocks shall be fixed to doors and windows as per size and shape and as directed by Engineer-in-Charge.

8.5.10 Measurements

Framework and paneling shall be measured separately.

(a) Framework of Shutters: The overall length and width of the framework of the shutters shall be measured nearest to a cm in fixed position (overlaps not to be measured in case of double leaved shutters) and the area calculated in square meters correct to two places of decimal. No deduction shall be made to form panel openings or louvers. No extra payments shall be made for shape, joints and labour involved in all operations described above.

(b) For paneling of each type or for glazed panel length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sq.cm. The portions of the panel insert or glazed panel inside the grooves or rebates shall not be measured for payment.

8.5.11 Rate

Rate includes the cost of materials and labour involved in all the operations described above. The framework and paneling of each type or glazed panels shall be paid separately. The rate for framework includes the cost of butt hinges and necessary screws etc. However, extra shall be paid for providing moulded beading where specified. Nothing extra shall be paid for plain beading.

8.6 FLUSH DOOR SHUTTERS: - DETAILED OF FLUSH DOOR SHUTTERS GIVEN BELOW

Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Printable type as per IS 2202 (Part 1). Nominal thickness of shutters may be 25, 30 or 35 mm. Thickness and type of shutters shall be as specified.
8.6.1 (a) Width and height of the shutters shall be as shown in the approved drawings or as indicated by the Engineer-in-Charge.
(b) All four edges of the shutters shall be square.
(c) The shutter shall be free from twist or warp in its plane.
(d) The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.

8.6.2 Core: Detailed of Core given below.
The core of the flush door shutters shall be a block board having wooden strips of (the maximum wooden strip width of 30mm) held in a frame constructed of stiles and rails. Each stile and rail of the frame shall be a single piece without any joint. The width of the stiles and rails in the frame including lapping, where provided shall not be less than 45 mm and not more than 75 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles.

End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lapping.

8.6.3 Face Panel: The face panel shall be made as detailed below.
(i) The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers.
(ii) The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm.
(iii) The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm.
(iv) The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips.
(v) Finished faces shall be sanded to smooth even texture.

(vi) Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328

8.6.4 Lipping :- This shall be done as detailed below.
(i) Lipping, where specified, shall be provided internally on all edges of the shutters.
(ii) Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25 mm.
(iii) For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm.
(iv) Joints shall not be permitted in the lipping.

8.6.5 Rebating
In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

8.6.6 Opening for Glazing
On the requirement of purchaser opening for glazing shall be provided and unless otherwise specified the opening for glazing shall be 250 mm in height and 150 mm or 200 mm in width. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

8.6.7 Tolerance
Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be ± 1, 2 mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

8.6.8 Adhesive
Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

8.6.9 Fixing
This shall be as specified in 8.5.7.

8.6.10 Measurements
Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured. All work shall be measured net as fixed and area calculated in square meters to nearest two places of decimal. No deduction shall be made for providing Venetian opening and opening for glazing.

8.6.11 Rates
The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters. Glazing when provided shall be measured & paid for separately as specified in 8.5.10.b.

8.7 WIRE GAUZE FLY PROOF SHUTTERS:- Wire gauze fly proof shutter shall be made by specified timber and shall be sawn in the direction of the grains. Sawing of timber shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding’s and moldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.
8.7.1 Stile and Rails
The Specifications shall be as described under 8.5.1.3. The stiles and rails shall be given a rebate to receive the wire gauze which shall form the panels.

8.7.2 Wire Gauze
(i) Wire Gauze shall be unless specified otherwise conform to para 8.2.7 and 8.5.4.e. The wire gauze shall be bent at right angles in the rebates of stiles and rails, turned back and fixed tight with blue tacks at about 75 mm centers, fixed alternately in the two faces of the rebates. Over this, wooden beading shall be fixed with brads or small screws at about 75 mm centers. The space between the beading and rebates, where the wire gauze is bent, shall be neatly finished with putty, so that the end of the wire gauze may not be visible.

8.7.3 Fixing Fittings. Wooden cleats, blocks, measurement and rates shall be as specified under para 8.5.

8.8 WALL LINING:-
Specified timber shall be used for wall lining, and specified timber shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, rounding, and moulding as shown in the drawings made, before assembly. Patching or plugging of, any kind shall not be permitted except as provided.

8.8.1 Grounds For wall lining:-
Grounds for wall lining shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 x 50 mm and top 35 x 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement: 3 fine sand) and batten of first class hard wood or as specified of size 50 x 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimeters centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

8.8.2 Paneling
8.8.2.1 Material : This paneling shall be decorative or non-decorative (Paintable) type as per design and thickness specified by the Engineer-in-Charge, of 2nd class teak wood, FPT-1 or graded wood prelaminated particle board or as specified in item.

8.8.2.2 Ornamental Work: The ornamental wood work shall be painted on the back with priming coat of approved wood primer before fixing the same to the grounds with screws, which shall be sunk into the wood work and their tops covered with putty. The ornamental work shall be made true and accurate to the dimensions shown in the working drawings. The fixing shall be done true to lines and levels. The planks for wall lining shall be tongued and grooved, unless otherwise specified.

8.8.2.3 Measurements of wall lining:- Measurement of wall lining shall be taken as detailed below.
(i) Length and breadth shall be measured correct to a cm.

(ii) Wall paneling such as teakwood paneling and block paneling, plain lining, and plain skirting each shall be measured separately in square meter nearest to two places of decimal.

(iii) The moulded work shall be measured in cm running meter i.e. in running meters stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in meter correct to a cm.

(iv) The measurements for ground shall be taken on the basis of cubical contents of battens and paid for separately, unless otherwise specified. Where only plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.
8.8.2.4 **Rate;** the rate includes the cost of materials and labour required for all the operations described above.

8.9 **SHELVES & Vertical portion of Cup boards :-** These shall be made as detailed below.

(i) Shelves and vertical partitions of cupboards shall be of timber planks fiber board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified.

(ii) Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint.

(iii) Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece teak wood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-Charge.

8.9.1 **Fixing of Planks for shelves :-**

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. Teakwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be ± 1.5 mm and in thickness 1 mm.

8.9.2 **Measurements**

Length and width of shelves and vertical partitions shall be measured correct to a cm. separately for each type of board stating its thickness. Area shall be calculated correct to 0.01 sqm.

8.9.3 **Rate**

It includes the cost of materials and labour required for all the operations described above.

8.10 **TRELLIS (JAFFRI) WORK :-**

For Jaffri work Specified timber/bamboo shall be sawn/cut in the direction of the grains. Sawing/cutting shall be truly straight and square, the timber/bamboo shall be planed smooth and accurate to the full dimensions, rebates, rounding's, and moulding as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.

8.10.1 **Plain Jaffri :-**

This shall consist of wooden strips or laths 35 x 10 mm section unless otherwise specified planed and nailed together at every alternate crossing. The strips shall cross each other at right angle and shall be spaced 35 mm apart, so as to form 35 x 35 mm square opening or as shown in the drawing. These shall be fixed with nails to the frame. To cover the ends of strips, 50 x 12 mm beading shall be fixed to the frame with screws. The finished work with a tolerance of ± 1 mm may be accepted.

8.10.2 **Measurements**

Width and height of plain trellis work and trellis shutters shall be measured overall correct to a cm. The area shall be calculated in square meters nearest to two places of decimal.

8.10.3 **Rate**

It includes the cost of materials and labour required in all the operations described above.

8.11 **HOLD FASTS**

These shall be made from mild steel flat 40 x 5 mm size conforming to IS 7196 without any burns or dents. 5 cm length of M.S. flat at one end shall be bent at right angle and one whole 11 mm dia shall be made in it for fixing to wooden frame with 10 mm dia nut bolt. The bolt head shall be sunk into the wooden frame, 10 mm deep and plugged with wooden plug. At the other end 10 cm length of the hold fast flat shall be forked and bent of length as specified at right angle in opposite direction and embedded in cement concrete block of
size 30 x 10 x 15 cm of mix 1:3:6 (1 cement; 3 coarse sand: 6 graded stone aggregate, 20 mm nominal size) or as specified.

8.11.1 Measurements
Measurements for the hold fasts shall be in number.

8.11.2 Rate
It includes the cost of labour and material involved in all the operations described above including fixing bolt and cement concrete blocks.

8.12 EXPANDED METAL, HARD DRAWN STEEL WIRE FABRIC AND WIRE GAUZE IN WOODEN FRAMES
Expanded metal, hard drawn steel wire fabric or wire gauge or weld mesh as described in the item of work shall be fixed to the window frames on the outside or inside as per detailed drawings or as directed by the Engineer-in-Charge. These shall be free from rust and other defects.

(a) Expanded Metal
This shall be in the form of rhombus with its opening diagonals 20 x 60 mm and strands 3.25 mm wide and 1.6 mm thick weighing 3.633 kg/m$^2$ unless otherwise specified.

(b) Welded Steel Drawn Wire Fabric
This shall conform to IS 4948 and shall have rectangular mesh of 75 x 25 mm size with wires of diameter not less than 5 mm longitudinally and 3.15 mm transversely. Its weight shall be not less than 7.75 kg/m$^2$ unless otherwise specified.

(c) Wire-Gauze: This shall be as per clause 8.2.7.

8.12.1 Fixing
Expanded metal, hard drawn steel wire fabric and wire gauze shall be cut in one piece to the size of the frame (out to out). Expanded metal and hard drawn steel wire fabric shall be fixed on to the frame with staples, over which wooden beading 60 x 20 mm shall be fixed with wood screws.

8.12.2 Measurements
The length and breadth shall be measured correct to a cm, the area from outside to outside of beading shall be calculated in square meter nearest to two places of decimal.

8.12.3 Rate
It includes the cost of labour and materials required for all the operations described above.

8.13 FITTINGS
Fitting shall be of mild steel brass, aluminum or as specified. Some mild steel fittings may have components of cast iron. These shall be wall made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

(a) Mild Steel Fittings: These shall be bright finish black stone enameled or copper oxidized (black finish), nickel chromium plated or as specified.

(b) Brass Fittings: These shall be finished bright satin finish or nickel chromium plated or copper oxidized or as specified.

(c) Aluminum Fittings: These shall be anodized to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in para 8.5.8. The fittings to be actually provided shall, be decided by the Engineer-in-Charge, Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminum fittings. Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be.
Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

8.13.1 Butt Hinges
These shall be of the following types according to the material used.
(a) Mild steel butt hinges (Medium).
(b) Cast brass butt hinges light/ordinary or heavy.
(c) Extruded aluminum alloy butt hinges.

8.13.1.1 Mild Steel (Medium): Mild Steel Butt Hinges shall be medium type manufactured from M.S. sheet. These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

Hinge Pin: Hinge pin shall be made of mild steel wire. It shall fit inside the knuckles firmly and riveted head shall be well formed so as not to allow any play or shake, and shall allow easy movement of the hinge. But shall not cause looseness.

Knuckles: The number of knuckles in the hinges of different sizes shall be as per IS 1341. The size of knuckles shall be straight and at right angle to the flap. The movement of the hinges shall be free and easy and working shall not have any play or shake.

Screw Holes: The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head wood screws and of the specified size for different types, and sizes of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of the wood screws. The nos. of screw holes shall as specified in IS 1341.

8.13.1.2 Cast Brass: These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidized or as specified. These shall generally conform to IS 205.

Hinge Pin: Hinge pin shall be made of brass or of stainless steel. The hinge pins shall be firmly riveted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

Knuckles: The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes: The screw holes shall be clean and counter sunk and of the specified size for different types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.
8.13.1.3 Extruded Aluminum Alloy: These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205.

Hinge Pin: Hinge pin shall be made of mild steel (galvanized or aluminum alloy). The aluminum alloy hinge pin shall be anodized. The hinge pin shall be finally riveted and shall be properly finished. The movement of hinges shall be free easy and square and shall not have any play or shake.

Knuckles: Number of knuckles in each hinge pin shall not be less than 5. The number of knuckles in case of sizes less than 40 mm be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes: The screw holes shall be suitable for counter sunk head wood screws and of specified sizes for different type of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

8.13.2 Parliament Hinges: The figure Parliament Hinge is given below.

(a) These shall be of mild steel cast brass or as specified, and shall generally conform to IS 362. The size of parliament hinges shall be taken as the width between open flanges. Mild steel parliament hinges shall be copper oxidized (thick finish) or as specified. The brass parliament hinges shall be finished bright, chromium plated or oxidized or as specified.

(b) The hinge pin shall be made of mild steel in the case of brass hinges. The hinge pin shall be mild steel (galvanized) in the case of aluminum alloy hinges. The hinge pin shall be firmly riveted and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake.

All screw holes shall be clean and counter sunk to suit the counter sunk head of wood screws specified.
8.13.3 Spring Hinges (Single or double acting)

8.13.3.1 These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453. Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

(a) When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage, or any appreciable deterioration of the components during or on completion of the test.

(b) The door shall require a force of 2.0 ±0.5 kg for 100 mm hinges and 3.0 ± 0.5 kg for 125 mm and 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 90°.

The size of spring hinge shall be taken as the length of the plate.

8.13.3.2 These shall be of the following type:

(a) **Mild Steel**: The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and riveted, or from solid drawn tube of thickness not less than 1.60 mm; or from mild sheet of 1.60 mm thickness pressed to from the two casing and the distance piece. It shall be stove enameled black or copper oxidized or as specified.

(b) **Cast Brass**: The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickel plated or copper oxidized or as specified.

8.13.4 Rising Hinges

These shall be made of brass, finished bright or chromium plated or oxidized or as specified Its shape and pattern shall be approved by the Engineer-in-Charge. The size of the rising hinge shall be taken as the length of its plate.

8.13.5 Continuous Piano Hinges: Continuous Piano Hinge is shown below.

![Fig. 8.7](image)

<table>
<thead>
<tr>
<th>Nominal Size</th>
<th>B</th>
<th>( l_1 )</th>
<th>( l_2 )</th>
<th>( l_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>40 ± 1</td>
<td>75 ± 2</td>
<td>25 ± 1</td>
<td>20 ± 1</td>
</tr>
<tr>
<td>30</td>
<td>30 ± 1</td>
<td>75 ± 2</td>
<td>25 ± 1</td>
<td>15 ± 1</td>
</tr>
</tbody>
</table>

All dimensions in millimeters

(a) These shall be made from mild steel or aluminum alloy sheet; these shall generally conform to IS 3818. All screw holes shall be clean and counter sunk. Piano hinges shall be fixed in the entire length of the cup board shutters. Its size will be the width of the two flaps when open.
(b) **M.S. Piano Hinges**: These shall be made from 1 mm or 0.80 mm thick M.S. sheets and shall be protected with anti-corrosive treatment, such as bright polished, chromium plated or oxidized finish. Hinge pin shall be of galvanized mild steel. It shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge, but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge **shall** be free and easy and working shall not have any play and shake.

(c) **Aluminum Piano Hinges**: These shall be made of aluminum alloy sheet and shall be anodized. The anodic coating shall not be less than the grade AC 15 of IS 1868. Hinge pin shall be made of aluminum alloy with anodic coating not less than the grade of AC-15 of IS 1868. The hinge pin shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge but shall not cause looseness. The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge **shall** be free and easy, and working shall not have any play and shake.

8.13.6 Tee Hinges
These shall be made from M.S. sheets and shall be either bright finished or stove enamelled black or as specified. These shall generally conform to IS 206 (Tee hinges shall be well made, free from burrs, flaws, and defects of any kind. The movement shall be square, and the working shall be free and easy without any play or shake. The hole for the hinge shall be central to the bore and shall be square. The hinge pin shall be firm and riveted over, so that the heads are well formed. All screw holes shall be clear and counter sunk and shall be suitable for the counter sunk head of wood screws.

8.13.7 Sliding Door Bolts (Aldrops)
These shall be of mild steel, cast brass, aluminum or as specified, and shall be capable of smooth sliding action.

8.13.7.1 **M.S. Sliding Door Bolts**: These shall be made of M.S. sheets and M.S. rods and shall generally conform to IS 281. M.S. sliding door bolts shall be copper oxidized (black finish) or as specified.

8.13.7.2 **Cast Brass Sliding Door Bolts**: These shall be made from rolled brass and shall generally conform to IS 2681. The hasp shall be of cast brass and secured to the bolt. After natively, the hasp and the bolt may be cast in one piece. The fixing and staple bolts shall be cast with 6 mm studs. Bolts shall be finished to shape and have threaded ends and provided with robs washers and nuts of square or hexagon type. All components shall be finished smooth and polished before assembly. Cast brass sliding bolts shall be finished bright or chromium plated or oxidized or as specified.

8.13.7.3 **Aluminum Sliding Door Bolts**: These shall be made of aluminum alloy and shall generally conform to IS 2681. Aluminum sliding door bolts shall be anodized. All screw holes shall be counter sunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminum fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole. The leading dimensions of the sliding door bolts are illustrated.

8.13.8 **Tower Bolts** These shall generally conform to IS 204 (Part. 1) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects- The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth. The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.9 meter.
8.13.8.1 Types of tower bolts shall be:-
(a) Aluminum barrel tower bolts with barrel and bolt of extruded sections of aluminum alloy. The knob shall be properly screwed to the bolt and riveted at the back.

(b) Brass tower bolts with cast brass barrel and rolled or cast brass bolt.
Or
Brass tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt.

The knobs of brass tower bolts shall be cast and the bolt fixed with knob, steel spring and ball shall be provided between the bolt and the barrel.

(c) Mild steel barrel tower bolts with mild steel barrel and mild steel bolt.
or
Mild steel tower bolts with mild steel barrel and cast iron bolts.

The plates and straps after assembly shall be firmly riveted or spot welded. The rivet head shall be properly formed and the rivet back shall be flush with the plate. These shall be made in one piece.

8.13.8.2 Unless otherwise specified bolt shall have finish as given below:

(a) Mild steel tower bolts (Types 1 and 2) Bolts bright finished or plated as specified and barrel and socket stove enamelled black,

(b) Brass tower bolts (Type 3 to 5) Bolt and barrel polished or plated as specified.

(c) Aluminum alloy tower bolts (Type 6) Bolt and barrel anodized.
The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

8.13.9 M.S. Locking Bolt with Holes for Pad Locks
This shall conform to IS 7534.

8.13.9.1 This shall be of mild steel polished bright or copper oxidized batch electrogalvanised or stove enamelled. In case of stove enamelled locking bolts, the bolt may be finished bright.

8.13.10 Pull Bolt Locks
These shall be of M.S. cast brass or aluminum as specified. M.S. pull bolt locks shall be copper oxidized (black finish) or as specified.

8.13.10.1 Brass pull bolt locks shall be finished bright, chromium plated or oxidized as specified. Aluminum pull bolt locks shall be anodized and the anodic coating shall not be less than grade A.C. 10 of IS 1868. The bolt shall be 10 mm in diameter and the fixing plate 3 mm thick. The stop block shall be screwed to the fixing plate by a small ball and spring over which the bolt shall slide.

8.13.10.2 The fixing plate shall have 4 holes for fixing to the door leaf, two of which shall be square to receive 6 mm dia. bolts with round heads, the remaining two shall receive machine screwed with lock nuts. The receiving plate shall be of the same width & thickness as the fixing plate & shall have 3 counter sunk holes. Where the bolt slides into wooden members, like the Chowkhats, which have a rebate, the receiving plate shall also be correspondingly shaped so as to fit into the rebate. The screws & bolts shall have the same finish as the main bolt. The leading dimensions of pull bolt locks are given in the drawing. The denominating size of the pull bolt locks shall be length of the fixing plate between guides plus the thickness of the guides.

8.13.11 Door Latch
This shall be of mild steel, cast brass, or as specified and shall be capable of smooth sliding action. In case, of mild steel latch, it shall be copper oxidized (black finish) or as specified and in case of brass, it shall be
finished bright, chromium plated or oxidized or as specified. The size of door latch shall be taken as the length of the latch.

8.13.12 Indicating Bolt (Vacant/Engaged)
These shall be of cast brass finished bright chromium plated, or oxidized or as specified. The shape and pattern shall be approved by the Engineer-in-Charge.

8.13.13 Mortice Lock and Latch This should generally conform to IS 2209.

(a) The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 65 mm, 75 mm and 100 mm as specified. The measured length shall not vary more than 3 mm from the length specified.

(b) Non-interchangeable Keys: Testing of non-interchangeable keys shall be as per IS 2209.

(c) The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body suitably by counter sunk head screw. The latch bolt shall be of specified material and of section not less than 12 x 16 mm for all sizes of locks. If made of two piece construction both parts shall be riveted. Ordinary lever mechanism with not less than two levers shall be provided. False levers shall not be used. Lever shall be fitted with one spring of phosphor bronze or steel wire and shall withstand the tests as provided in IS 2209.

(d) Locking bolts, spring and strike plate shall conform to IS 2209.

(e) Handles: These shall conform to IS 4992.

(f) Keys: Each lock shall be provided with two keys.

8.13.14 Mortice Latch (with Locking Bolt)
These are generally used in doors of bath rooms, WC’s and private rooms.

8.13.14.1 Mortice latch shall, in respect of shape, design and mechanism of the latch and its components parts, generally conform to IS 5930. The material used for the different component parts of tie latch shall comply with Tables 1 and 2 of IS 5930, unless otherwise specified.

8.13.14.2 The size of the latch shall be denoted by the length of the body towards the face and shall be 65 mm, 75 mm or 100 mm as specified. The depth of the body shall not be more than 15 mm.

8.13.14.3 The latch shall be of size 10 x 18 mm of shape as shown in Fig. 1 of IS 5930. The locking bolt shall be of section not less than 8 x 25 mm for all size of locks. The mechanism of the latch bolt, its spring, striking plate etc. shall be as described in IS 5930.

8.13.14.4 The handles provided shall conform to IS 4992.

8.13.15 Mortice Lock and Latch (Rebated)
These are slightly different from mort ice lock described in 8.13.1 and are designed for use in double leaved doors. These should generally conform to IS 6607.

8.13.16 Mortice Night Latch
This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room. This should generally conform to IS 3847.

8.13.16.1 It shall be cast or sheet brass, cast or sheet aluminum alloy or Mild steel as specified and of best quality of approved make. These shall be bright finished or copper oxidized (black) finish as specified.
Nominal size of the latch shall be denoted by the length of the face over the body in mile-meters. These shall have not less than two levers. False (Dummy) levers shall not be allowed.

8.13.16.2 Keys: Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

8.13.17 Cupboard or Wardrobe Lock
This should generally conform to IS 729. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. This shall be made of cast brass and shall be of the best make of approved quality these shall be finished bright or chromium plated or oxidized or as specified. The size of the lock shall be denoted by the length of the face across the body in mm. These locks shall be fitted with four, five or six levers as specified. False (dummy) taverns shall not be used.

8.13.18 Kicking Plates
This shall be of brass (finished bright or chromium plated or oxidized) bronze, stainless steel, aluminum or as specified. Aluminum kicking plates shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5 mm in case of stainless steel. Shape of the plate shall be as specified. This shall have beveled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of the plate. The shape and pattern shall be according to the drawings and as approved by the Engineer-in-Charge.

8.13.19 Door Handles (Doors and Windows) These should generally conform to IS 208. The door handles shall be well made and free from defects- These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

8.13.19.1 Door handles shall be of the following types according to the material used:

(a) Cast or Sheet Aluminum Alloy Handles; These shall be of aluminum of specified size, and of shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6, Aluminum handles, shall be anodized and the anodic coating shall not be less than grade AC 15 - IS 1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.

(b) Cast Brass Handles: These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidized or as specified.

(c) Had Steel Handles : These shall be of mild steel sheet, pressed into oval section. The size of the handles will be determined by the inside grip of the handle. Door handles shall be 10 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6., Iron handles shall be copper oxidized (black finish) or stove enameled black or as specified.

8.13.20 Floor Door Stopper
The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. it shall be of brass finished bright, chromium plated or oxidized or as specified. The size of floor stopper shall be determined by the length of its plate- It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel.
screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed white closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminum stopper shall be anodized and anodic film shall not be less than grade AC-10 of IS 1868.

8.13.21 Hanging Rubber Door Stopper
These shall be of cast brass, finished bright, chromium plated or as specified. Aluminum stopper shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

8.13.22 Universal Hydraulic Door Closer (Exposed Type)
These shall be made of cast iron/aluminum alloy/zinc alloy and of shape and pattern as approved by the Engineer-in-Charge. These shall generally conform to IS Specifications for door closers (Hydraulically regulated) IS 3564.

8.13.22.1 The door closers may be polished or painted and finished with lacquer to desired colour. Aluminum alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be pickled, scrubbed and rinsed to remove grease, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphate treatment in accordance with IS 3618.

8.13.22.2 The nominal size of door closers in relation to the weight and the width of the door size to which it is intended to be fitted shall be given in Table 8.18.

<table>
<thead>
<tr>
<th>Designation of closers</th>
<th>Mass of the door (kg)</th>
<th>Width of the door (mm)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Upto 35</td>
<td>Upto 700</td>
<td>For light doors such as double leaved and toilet</td>
</tr>
<tr>
<td>2</td>
<td>36 to 60</td>
<td>701 to 850</td>
<td>Interior doors, such as of bed rooms, kitchen and</td>
</tr>
<tr>
<td>3</td>
<td>61 to 80</td>
<td>851 to 1000</td>
<td>Main doors in a building, such as entrance doors</td>
</tr>
</tbody>
</table>

8.14.22.3 Performance Requirements: After being fitted in its position when the door is opened through 90°, the same should swing back to angle of 20° ± 5° with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final position the door smoothly negotiates with the latch.

8.13.24 Quadrant Stays 300 mm
These shall be made of cast brass and finished bright or chromium plated or as specified. The shape and pattern shall be approved by the Engineer-in-Charge. It shall not weigh less than 0.20 kg each.

8.13.25 Hasp and Staple Safety Type This shall be made of mild steel, cast brass or aluminum as specified. This shall generally conform to IS 363. M.S. Hasp and staples shall be finished black enameled, or copper oxidized (black finish) or as specified. Brass hasp and staples shall be finished bright chromium plated or oxidized or as specified. Aluminum hasp and staples shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868.

8.13.25.1 M.S. hasp and staples shall be manufactured from M.S. sheet and brass hasp and staples by casting and Aluminum hasp and staples shall be made from dye section. The hinge pin which in all cases shall be of mild steel shall be firm and its riveted heads well formed. The movement of hasp shall be free, easy and square and shall not have any play or shake. The hasp shall fit, in the staple correctly. The size shall be determined by the length of the bigger of the hasp.
8.13.25.2 The staple except in the case of cast one, shall be riveted properly to its plate. The ends of the hinge pin for the safety type hasp shall be riveted and properly finished. All screw holes shall be clean and counter sunk to suit counter sunk wood screw. All edges and corners shall be rounded.

8.13.26 P.T.M.T (Polytetra Methylene Tetraphthalate) Fittings
PTMT (Polytetra Methylene Tetraphthalate) is an engineering plastic (raw material imported) and have following physical properties:-

(i) Tensile Strength 500 Kg/cm²  
(ii) Compressive Strength 900 Kg/cm²  
(iii) Rockwell hardness L-scale 75  
(iv) Working temperature -45° to 120°C.  
(v) E Value 85000 Kg/cm²  
(vi) Density 1.3gm/cc  
(vii) Impact Strength No Break

P.T.M.T. fitting shall be in different colours like White, Green, Blue, Derby Brown, Mushroom, Black, Gold, Silver & Bronze or any colours agreed by the manufactures and purchaser.

P.T.M.T. fittings are suitable for internal doors shutters kitchen, bath w.c. & cabinet etc. These shall not be used in external door and where security is concern.

Screws used for fittings shall be counter sunk cross head of chromium plated brass or stainless steel. Sizes of screws shall be of same size as used in case non ferrous material door/window fittings.

8.13.26.1 P.T.M.T. Butt Hinges: These shall of the material as mentioned in para 8.13.26.0 above. These shall be of required colour/shade ceramic look, glassy smooth surface. These shall be of required size and thickness.

8.13.26.1.1 Hinge Pin: Hinge pin shall be made of 5.5 mm dia stainless steel. It shall fit inside the knuckles firmly and riveted head (head covered with same material as of hinge) shall be well formed so as not to allow any play or shake and shall allow easy movement of the hinge, but shall not cause looseness.

8.13.26.1.2 Knuckles: The number of the knuckles in hinges shall be as per IS 1341. The shape of knuckles shall be straight and right angle to flap. The movement of the hinge shall be free and easy and working shall not have any play or shake.

8.13.26.1.3 Screw Holes: The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head cross head wood screws and of the specified sizes for different type and sizes of hinges. The size of the holes shall be such that when it counter sunk it shall be able to accommodate the full depth of counter sunk of screws.

8.13.26.2 P.T.M.T. Door Handles: The door handles shall be of material as mentioned in para 8.13.26. above moulded to required shape and size. The size & thickness etc. of the handle shall be determined by the inside grip of the handle. These shall be moulded as solid sections. The body of the handle shall not be hollow. Door handles shall be 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood. (Cross head) screws of designation No. 6.

8.13.26.3 PTMT Tower Bolt: The tower bolt shall be generally barrel type of material as mentioned in para 8.13.26 moulded to required shape and size. Size (length, dia, length of rod, number of holes) shall generally confirm to IS 204 P1 & P-it. The rod shall be solid. If it in hollow it shall be provided with stainless steel rod of required dia. for its strength protective coat of wood primer, polish or varnish.

8.14 LAMINATED VENEER LUMBER (LVL)
Laminated Veneer Lumber door frames and shutters shall conform to IS 14616.
8.14.1 Material
8.14.1.1 Laminated Veneer Lumber (LVL)
(a) Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued together having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5 mm.

(b) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes,. shakes, objectionable decay or termite attack, except that for the face veneers none of these defects nor cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of ± 5 %.

(c) Adhesives: Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

(d) Preservatives: Veneers used for LVL shall be given suitable preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use. All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall then be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 °C to 180° C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m³ Veneers shall be scarf jointed only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600 mm.

8.14.2 Moisture Content
The average moisture content of 3 test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

8.14.3 Tests
8.14.3.1 The tests as per Table 1 of IS 14616 shall be carried out by the manufacturer on the LVL (Laminated Veneer Lumber) sections on each batch.

8.14.3.2 The manufacturer shall get the tests done on at least three samples of each batch by the standard method of test to ensure quality and performance of the material as per para 8.2 of IS 14616.

8.14.3.3 The manufacturer shall provide a certificate with the delivery challan indicating that the material conforms to IS 14616 along with the copy of the test report of the relevant batch.

8.14.4 Laminated Veneer Lumber (LVL) Door Shutters
8.14.4.1 This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, god owns etc.

8.14.4.2 The material of each lot shall be supported by a certificate to that effect:
Each lot of LVL materials shall be accompanied by the test reports. Fabricator shall take up manufacturing of shutters only if provisions of clause 8.14.3 are fulfilled; failing which, shutters so manufactured are liable for rejection.

8.14.4.3 Paneling Materials
(a) Plain Particle Board: Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848. (Ref. para 8.2.3)
(b) **Pre-laminated Particle Board:** Pre-laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per para 8.2.11 (Marine plywood).

(c) **Medium Density Fiber Board:** Medium density fiber board used for panels shall conform to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

(d) **Pre-laminated Medium Density Fiber Board:** Pre-lamination in pre-laminated medium density fiber board shall conform to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board shall be as per para 8.2.5 above.

(e) **Glass:** Glass for glazing shall conform to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass and coloured glass may also be specified by the Engineer-in-Charge. (Ref. para 8.2.8).

(f) **Wire Gauze:** Wire gauze shall generally conform to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm. (Ref para 8.5.4(e))

8.14.6 **Construction and Workmanship:**-construction and workmanship shall be as given blow.

8.14.6.1 Laminated Veneer Lumber (LVL) paneled, glazed and paneled and glazed shutter shall be constructed in the form of LVL framework of stiles and rails with panel inserts conforming to para 8.14.4 above of plain or prelaminated particle board, plain or prelaminated medium density fiber board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beading as specified. The stiles, top rails, lock rails and bottom rails shall be jointed to each other by Mortice and tenon joints (See Fig.). Rails having width of 150 mm or more shall have plain double tenon joints as shown in Fig. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub Mortice & tenon joint. After assembling shutter complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon & Mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubber wood/plantation wood lipping (See Fig.). Lipping shall be seasoned and chemically treated as per clause 8.14.3. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lipping shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m².
8.14.6.2 All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any warp or bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

8.14.6.3 **Beading:** All the panels except glass and wire gauze shall be fixed with grooves (see Fig.) but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable headless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401-1982.

8.14.6.4 Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only. Mullions and glazing bars shall be stationed to the maximum depth which the size of the member would permit or to a depth of 25 mm, whichever is less. Two common methods for jointing of panels with stiles/rails are shown in Fig. The minimum depth of grooves of stiles and rails shall be 12 mm for all types of paneling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.
LVL Shutters shall be manufactured in factories under controlled conditions.

8.14.7 Paneling

8.14.7.1 Plain and Prelaminated Particle Board Paneling: The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

8.14.7.2 Wire Gauze Paneling: Wire gauze panel shall be so designed that no single panel shall exceed 0.5 sqm in area.

8.14.8 Rebating
In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or square type as shown in Fig D as per clause 6.12 of IS 1003 (part-1).

8.14.9 Gluing of Joints
The contact surfaces of tenon and Mortice shall be treated before putting together as per clause 6.13 of IS 1003 (Part-1). All the tenon and Mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

8.14.10 Dimensions, Sizes and Tolerances
The finished dimensions and tolerances of the different components of door shutter shall be as per para 8.5.1.4.a.

Tolerances: Tolerance on the size of door shutter shall be +3 mm and in thickness + 1.2mm.

8.14.11 Locations of Fittings and Accessories
Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50 mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described in para above.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per schedule of fittings decided by the user. The fittings shall conform to specifications as described in clause 8.13.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, sizes and shape of louver or vision panel opening shall be as specified.

8.14.12 Finish
All the four edges of the shutter shall be square. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

8.14.13 Glazing
Glazing in the shutters of door and window shall be as per sub head 21.0 In specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.
8.14.14 Tests
8.14.14.1 Routine Tests: The following test shall be carried out by the fabricator on shutters during the process of fabrication in the factory's laboratory to be developed for this specific purpose before dispatch of shutters.

**TABLE 8.20**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Test.</th>
<th>Acceptability Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dimensions and Defects of Squareness Test</td>
<td>As per IS 4020</td>
</tr>
<tr>
<td>2.</td>
<td>General Flatness Test</td>
<td>As per IS 4020</td>
</tr>
<tr>
<td>3.</td>
<td>Local Paleness Test</td>
<td>As per IS 4020</td>
</tr>
<tr>
<td>4.</td>
<td>Flexure Test</td>
<td>As per IS 4020</td>
</tr>
</tbody>
</table>

8.14.14.2 Type Test: The manufacturer shall also have the performance of the shutters tested as per IS 4020 by the following tests as given in Table 8.21.

**TABLE 8.21**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Test</th>
<th>Acceptability Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Impact indentation test</td>
<td>Not more than 0.2 mm</td>
</tr>
<tr>
<td>2.</td>
<td>Screw withdrawal /Holding power test (a) Face (Min)</td>
<td>2700 N</td>
</tr>
<tr>
<td></td>
<td>(b) Edge (Min)</td>
<td>2300 N</td>
</tr>
<tr>
<td>3.</td>
<td>Edge loading test (a) Deflection</td>
<td>Not more than 5 mm</td>
</tr>
<tr>
<td></td>
<td>(b) Residual Deflection</td>
<td>Not more than 0.50 mm</td>
</tr>
<tr>
<td>4.</td>
<td>Shock resistance test (a) Soft &amp; tight weight body impact</td>
<td>No visible damage observed</td>
</tr>
<tr>
<td></td>
<td>(b) Soft and heavy weight body impact</td>
<td>-do-</td>
</tr>
<tr>
<td>5.</td>
<td>Buckling test (a) Deflection/Deformation</td>
<td>Not more than 50 mm</td>
</tr>
<tr>
<td></td>
<td>(b) Residual Deformation</td>
<td>Not more than 5 mm</td>
</tr>
<tr>
<td>6.</td>
<td>Misuse test</td>
<td>Not be any permanent deformation observed</td>
</tr>
<tr>
<td>7.</td>
<td>Slamming test</td>
<td>No visible damage observed</td>
</tr>
</tbody>
</table>

(i) All the tests to be carried under 8.14.14 shall be got done through approved/reputed lab on at least three samples to ensure the quality and performance of the door shutters on completing manufacturing of 5000 door shutters or once in 12 months whichever is earlier. Record of manufacturing of shutters shall be maintained to ensure the required frequency. The fabricator shall also provide a certificate of shutters conforming to this specification along with each lot. The fabricator shall also provide test reports carried under para 8.14.14.1 and 8.14.14.2 with each lot of supply.

(ii) Tests to be conducted by field units: The Engineer-in-Charge shall also have options to get any or all other test covered in 8.14.14 done at his own cost. If the shutter fails to satisfy the test, cost will be borne by the supplier and consignment shall be rejected.
8.14.15 Measurement:- The measurement of LVL door shutter shall be done as given blow.
1. Length and width of the shutter shall be measured to the nearest centimeter in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame.
2. Overlap of the two shutters shall not be measured.
3. All work shall be measured net as fixed and area calculated in square meters to nearest two places of decimal. No deduction shall be made to form panel opening louver Venetian opening and opening for glazing.
4. No extra payment shall be made for shape, joints and labour involved in operations described above.

8.14.16 Rates
The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaf shutters. Fittings described in para 8.14.11 shall be payable extra. Nothing extra shall be payable for complying with the provisions described in para 8.14.1 & 8.14.14.2. Cost of tests as described in para 8.14.14.2 shall be borne by Deptt. If test reports are found satisfactory. Rate shall include cost of material and labour involved in providing plain beading. Extra shall be paid for providing moulded/plain beading on panels where specified.

8.15 PARTITIONS:- Generally following material are used in partitions.
8.15.1 (i) Gypsum Board conforming to IS 2095 (Pt.-I)
(ii) Non asbestos multi-purpose cement board conforming to IS 14862
(iii) Tapered edge calcium silicate board.
**Tapered Edge Calcium Silicate Board** is manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminum or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

8.15.2 Installation
The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge.

8.15.3 Jointing & Finishing
Joints of the boards are finished with specially formulated Jointing compound and fiber tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

8.15.4 Fitting and Fixtures
It is easy and simple to attach different fittings to wall paneling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

8.15.5 Tolerance
Tolerance in dimensions shall be ± 5 mm.

8.15.6 Measurements
(a) The length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made of openings of areas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.
(b) For openings exceeding 0.40 sqm. In area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such openings.

8.15.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc.
8.16 UPVC- DOOR FRAMES

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, and Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desired proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

8.16.1 UPVC Door Frame

UPVC door frame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extruded UPVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm ± 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitered and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm ± 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge.

8.16.2 Fixing of Frames:- PVC door frame shall be fixed as detailed below.
1. All civil work with finishing should be completed before the fixing of the frames.
2. The frames are to be fixed directly on the plastered wall.
3. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untilled at the location where the frames are to be fitted.
4. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor.
5. The frame shall be fitted truly in plumb.
6. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the center.
7. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

8.16.3 Measurements
The outer length of the vertical and horizontal members of UPVC door frame shall be measured in running meters including embedded length in floor corrected upto a cm.

8.16.4 Rate
The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

8.17 PVC DOOR SHUTTERS
The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

8.17.1 24 mm thick PVC Door Shutter.
8.17.2 30 mm Thick PVC Door Shutters.
8.17.3 Sampling and Criteria for Conformity

8.17.3.1 General Precautions
The test specimens shall not have been exposed to a temperature below 40°C for 24 hours immediately preceding the test and shall be free from all/visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.
If any test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

8.17.3.2 Sampling
Sampling criteria for conformity shall be in accordance with IS 4020 (Part -I). Lot in any consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to form a lot. The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Col. 1 & Col. 2 of Table 8.22.

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Sample size</th>
<th>Permissible No. of Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 to 50</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>51 to 100</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>101 to 150</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>151 to 300</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>301 to 500</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>501 and above</td>
<td>80</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: For lot size 25 or less, number of samples to be taken for testing shall be as agreed to between the manufacturer & Engineer-in-charge.

Number of Tests: The samples selected as in column 2 of Table 8.22 shall be as agreed to between the manufacturer & Engineer-in-charge.
8.17.3.2. **Criteria for Conformity:** The lot shall be considered conforming to the requirements if the number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number mentioned in col. 3.

8.17.4 **Test**

The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16).

(a) **Dimension and Squareness Test:** Door shutters when tested in accordance with IS 4020 (Part 2) the dimensions of nominal width and height will be within a limit of $\pm 5$ mm. The door shutter shall not deviate by more than 1 mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. The nominal thickness of the shutter shall be within a limit of $\pm 1.5$ mm.

(b) **General Flatness Test:** Door shutter, when tested in accordance with IS 4020 (Part 3) the twist, cupping and warping shall not exceed 6 mm.

(c) Local **Plainness Test:** Door shutters, when tested in accordance with IS 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

(d) **Impact Indentation Test:** Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delimitation and the depth of indentation shall not be more than 0.2 mm.

(e) **Edge Loading Test:** Door shutters, when tested in accordance with ARE 4020 (Part 7) the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

(f) **Shock Resistance Test:** Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8), there shall be no visible damage in any part of the door after twenty five blows on each end.

(g) **Buckling Test:** Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show any deterioration and any residual deformation more than 5 mm after 15 min. of unloading and the initial deflection also shall not be more than 50 mm.

(h) **Slamming Test:** Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have any damage in any part of the door at the end of successive impacts. Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have any visible damage in part of the door at the end of 100 successive impacts.

(l) **Misuse Test:** Door shutters, when tested in accordance with IS 4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

(j) **Screw Holding Test:** Door shutters, when tested in accordance with IS 4020- Part 16, the load shall not be less than 1000 N.

(k) **End Immersion Test:** Door shutters, when tested in accordance with IS 4020- Part 13, the shutter shall not show any delimitation.

(l) **Knife Test:** Door shutter, when tested in accordance with IS 4020 - Part 14, the grading shall be standard & excellent.

(m) **Glue Adhesion Test:** Door shutters shall be tested in accordance with IS 4020 - Part 15. There should be no delimitation.
8.17.5 Fixing of Shutters
PVC door shutter shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk into the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm/30 mm. The hinges used should be of stainless steel.

8.17.6 Tolerance
The tolerance on the width & height of the door shall be ± 5 mm & the tolerance on the nominal thickness of the door shall be ± 2 mm.

8.17.7 Fittings
Fittings shall be provided as per schedule of fittings decided by Engineer-in-Charge. In moisture prone areas M.S. fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

8.17.8 Measurements
Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

8.17.9 Rate
The specified rate includes the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

8.18 PVC Door Frame
Solid PVC door frame and shutter shall be as per para 8.18.

8.18.1 Solid PVC Door Frames:- Solid PVC door frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelim veneer shade as approved by the Engineer-in-charge. The weight per running meter of the door frame including reinforcement should be a minimum of 1.5 kg./sq. mtrs. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be joined to each other using solvent adhesive conforming to IS 14182. A tolerance of ± 3 mm shall be permitted in the specified dimension of PVC section in the door frames.

8.18.2 Fixing of Frames, Measurements & Rates
These shall be as specified under para 8.16.2 to 8.16.4

8.19 Panel PVC Door Shutter
Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelim veneer shade as approved by the Engineer-in-Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-charge.

8.19.1 Sampling and Criteria for Conformity
As per para 8.17.3 above.

8.19.2 Tests
As per para 8.17.4 except para (k), (l) & (m).

8.19.3 Fixing of Shutters
As per clause 8.17.5. In addition, it may be ensured that while fixing hinges the screws pass through the two opposites surfaces of the M.S. reinforcement.
8.19.4 Tolerance, Fittings, Measurements & Rates
These shall be as specified in para 8.17.6 to 8.17.9.

8.20 FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES
The door frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

8.20.1 Tolerance
Tolerance of size of frame to be ± 2 mm and on size of rebate to be + 1 mm.

8.20.2 Finish
The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregnation, colour blots and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour & shade as approved by Engineer-in-Charge.

8.20.3 Fixing of Frame, Measurements & Rates
These shall be as specified in para 8.16.2 to 8.16.4.

8.21 FIBRE GLASS REINFORCED PLASTIC (FRP) SHUTTERS
FRP - Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

8.21.2 Location of Fittings and Accessories
The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable indication by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminum.

8.21.3 Sampling & Criteria for Conformity Shall be as per para 8.17.3.

8.21.4 Finish Shall be as per para 8.20.2

8.21.5 Tests shall be as per para 8.17.4 except clause (j), (k), (l) & (m).

8.21.6 Fixing of shutter, Tolerance, Measurements & Rates
These shall be as specified in para 8.18.5 to 8.18.9

8.22 SOLID PVC FOAM PROFILE DOORS

8.22.1 Solid PVC Foam profile frames
The solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. The doors are provided with naturally strong stiffener frame and sandwich paneled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. (Fig. 8.25). Supporting bar at bottom side of frame shall be provided for maintaining frame in plumb. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-charge. The PVC door frame should have shore hardness more than 70.

8.22.2 Fixing of Frames shall be as per para 8.16.2
8.23.3 Measurements & Rates
These shall be as specified in para 8.16.4 & 8 16.4

8.23 SOLID PVC FOAM SHUTTERS
The solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Doors are provided with naturally strong stiffener frame and sandwich Panelled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

8.23.1 28 mm Thick Door Shutters
The profile is cut in required length to make vertical & horizontal stile. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. G.I ‘C’ stiffener 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is joined using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicone sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & ‘C’ type G.I stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look. (Fig. 8.26).The fabrication shall be done in factory as per nomenclature of the item and directions of Engineer” in-Charge.

8.23.2 Sampling and Criteria for conformity, Tests, Fixing of shutters, Tolerance, Fittings, Measurements & rates
These shall be as specified in para 8.17.3 to 8.17.9.

8.24 FACTORY MADE FIBRE GLASS REINFORCED PLASTIC CHAJJA
The FRP chajjas shall be 4 mm thick of required colour/size, design and drawing as approved. The chajjas shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge. (Fig.).

The FRP chaja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modulus of elasticity, good textile processing and excellent fiber reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be divisionally stable, shall have moisture and corrosion resistance.

8.24.2 Tolerance
Tolerance of ± 10 mm in overall size of FRP chajja is permissible.

8.24.3 Finish
The F.R.P. laminate to be finished with polyurethane based or equivalent paint as final coat or gloss or mat followed by clear lacquer coat to get the shine of required shade.

8.24.4 Measurement and Rate
The width and length to be measured in centimeters and area to be calculated as square meter correct upto two places of decimal. The rate includes cost of all the materials; labour scaffolding, fittings & fixing upto all heights etc. involved in operations described above, but excludes the cost of paint.

8.25 WALL PANELING
All specification same as per para 8.15.1 to 8.15.7.
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9.0 DEFINITIONS/TERMINOLOGY

Bead
It is a single run of weld metal deposited on surface.

Butt Weld
It is a weld in which the weld metal lies substantially within the extension of the planes are the surfaces on the parts joined.

Crater
It is a depression left in weld metal where the arc was broken or the flame was removed.

End Crater
It is a crater at the end of a weld or at the end of a Joint.

Elongation
The increase in length of a tensile test piece under stress. The elongation at fracture is conventionally expressed as a %age of the original gauge length of a standard test piece.

Fillet Weld
It is a weld of approximately triangular cross-section joining two surfaces approximately at the right angles to each other in a lap joint, tee joint or corner joint. Type of fillet weld are :-
   (1) Continuous
   (2) Intermittent.

Fusion Welding
Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.

Mastic
It is a weather proofing compound usually with a putty base which remain pliable and plastic.

Non- fusion welding
It is a term applied to the deposition, by the Oxy-Acetylene process of filler metal on parent metal without fusion of the latter.

Oxy-Acetylene Pressure Welding
Pressure welding in which any Oxy-Acetylene flame is used to make the surface to be united plastic. No filler metal is used.

Run
The metal deposited during one passage of the electrode or blow pipe in the making of a joint.

Sash
It is a complete industrial window unit, whether of the fixed or opening type.

Weld
It is a union between two pieces of metal at faces rendered plastic or liquid by heat or pressure, or both, Filler metal may be used to effect the union.

Micro-Alloying Elements
Elements such as niobium, boron, vanadium and titanium added singly or in combination to obtain higher strength to weight ratio and better toughness, formability and weld ability as compared to unalloyed steel of similar strength level,

Weldability
It is a metallic substance is considered to be weldable by a given process and for the given purpose. when metallic continuity to a stated degree can be obtained by welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.
Controlled Rolling
It is a hot rolling process in which the temperature of the steel and its reduction ratio are controlled, particularly during the final rolling passes, in order to achieve fine grain micro structure and optimum mechanical properties.

Normalizing Rolling
It is a hot rolling process in which the final rolling passes are carried out at a suitable higher temperature, followed by cooling in natural air to a temperature below the transformation temperature, in order to produce a structure, analogous to that obtained by a separate normalizing treatment of hot rolled product.

9.1 Material
9.1.1 Steel
If steel arranged by contractor shall be tested in field for tensile strength and bend test by the procedure in IS 1599. Minimum 20 tonne of steel taken out for test and the frequency of the testing shall be every 20 tonne or part thereof. Above test are mandatory

9.1.1.1 Supply of Material: General requirements relating to supply of structural steel shall conform to IS 8910.

9.1.1.2 Grades: The grade of steel shall be nine as given in table for mechanical properties and composition table no. 9.1 and 9.2

Chemical composition of steel shall be as per table below

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<tr>
<td><strong>S .N.</strong></td>
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<td></td>
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<tr>
<td>1</td>
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<td>8</td>
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<tr>
<td>9</td>
</tr>
</tbody>
</table>

Notes:
1. Carbon equivalent (CE) based on ladle analysis

2. When the steel is killed by aluminum alone, the total aluminum content shall not be less than 0.02%. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10%. When the steel is silicon-aluminum killed, the silicon content shall not be less than 0.30% and total aluminum content shall not be less than 0.01%.

3. Micro alloying element like Nb, V, Ti and B shall be added singly or in combination. Total micro alloying element shall not be more than 0.25.
4. New grades designation system based on yield stress has been adopted, simultaneously old designations have also been given in parentheses.

5. Steel of qualities A, B and C are generally suitable for welding processes. The weld ability increases from quality A to C.

6. Copper may be present between 0.20 to 0.35% as mutually agreed to between the purchaser and the manufacturer. The copper bearing quality shall be designated with a suffix Cu, for example, E 250 Cu. In case of product analysis the copper content shall be between 0.17 & 0.38%.

7. Nitrogen content of steel shall not exceed 0.012% which shall be ensured by the manufacturer by occasional check analysis. For micro alloyed steel this is to be reduced to 0.009%.

8. The steel, if required may be treated with rare earth element for better formability

9. Lower limits for carbon equivalent and closer limits for other elements may be mutually agreed to between the purchaser and the manufacturer.

10. Incidental element-Elements not quoted in Table 1 shall not be intentionally added to steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacture of such elements which affect the hardenability, mechanical properties and applicability.

Mechanical Properties of the steel shall be as per given below

<table>
<thead>
<tr>
<th>Grade Designation</th>
<th>Quality</th>
<th>Tensile strength Min. MPa</th>
<th>Yield stress, ReH Min. MPa</th>
<th>%age elongation at Guage length Lo 5.65√30 Min.</th>
<th>Internal Bend Diameter Mn.</th>
<th>Charpy V-Notch Impact Energy Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;20</td>
<td>20-40</td>
<td>&gt;40</td>
<td>^25</td>
<td>&gt;25 at Room Temp. AT 20°C</td>
</tr>
<tr>
<td>E165 (Fe 290)</td>
<td>-</td>
<td>290</td>
<td>165</td>
<td></td>
<td>23</td>
<td>2t</td>
</tr>
<tr>
<td>E250(Fe410W)</td>
<td>A</td>
<td>410</td>
<td>250</td>
<td>240</td>
<td>23</td>
<td>3t</td>
</tr>
<tr>
<td>E250 (Fe410W)</td>
<td>B</td>
<td>410</td>
<td>250</td>
<td>240</td>
<td>23</td>
<td>2t 3t</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>410</td>
<td>250</td>
<td>240</td>
<td>23</td>
<td>2t 3t</td>
</tr>
<tr>
<td>E300 (Fe 440)</td>
<td>-</td>
<td>440</td>
<td>300</td>
<td>290</td>
<td>280</td>
<td>22 2t 3t</td>
</tr>
<tr>
<td>E350 (Fe 490)</td>
<td>-</td>
<td>490</td>
<td>350</td>
<td>330</td>
<td>320</td>
<td>22 2t 3t</td>
</tr>
<tr>
<td>E410 (Fe 540)</td>
<td>-</td>
<td>540</td>
<td>410</td>
<td>390</td>
<td>380</td>
<td>20 2t 3t</td>
</tr>
<tr>
<td>E450 (Fe 570)</td>
<td>D</td>
<td>570</td>
<td>450</td>
<td>430</td>
<td>420</td>
<td>20 2t 3t</td>
</tr>
<tr>
<td>E450 (Fe 590)</td>
<td>E</td>
<td>590</td>
<td>450</td>
<td>430</td>
<td>420</td>
<td>20 2t 3t</td>
</tr>
</tbody>
</table>

1. 1 MPa = 1MN/m² 0.102 kgf/mm² = 144.4 psi
2. Temperature of Charpy impact value's will be subject to mutual agreement.
3. The more stringent requirements than those given above may be as agreed to between the purchaser and the manufacturer.
9.1.3 Manufacture: The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier. If required, secondary refining may follow steel making, as also normalizing rolling/controlled rolling during manufacturing of sections or as per the agreement between the purchaser and the manufacturer/supplier.

9.1.4 Freedom from Defects
9.1.4.1 All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/jagged and imperfect edges and all other harmful defects.

9.1.4.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4% below the minimum specified thickness. Reduction in thickness by grinding greater than 4% but not exceeding 7% may be made subject to mutual agreement between the purchaser and manufacturer/supplier.

9.1.4.3 Subject to agreement with the purchaser, surface defects which cannot be dealt with in para 9.1.4.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that:
   (a) After complete removal of the defects and before welding, the thickness of the item is not to be reduced by more than 20% at any place.
   (b) Welding is carried out by procedure approved by competent authority with approved electrodes and the welding is ground smooth to the correct nominal thickness;
   (c) Subsequent to the finish grinding, the item may be required to be normalized or otherwise heat-treated at the purchaser's discretion.

9.1.4.4 Welding as mentioned in para 9.1.4.3 is not permissible for grade designation of E 250 material.

9.1.5 Chemical Composition: Ladle Analysis the ladle analysis of the steel, when carried out by the method specified in the relevant part of IS 228 or any other established instrumental/chemical method, shall be as given in Table 9.1 as per para 9.1.2. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier.

9.1.2 Rivets
Rivets shall be made from rivet bars of mild steel as per IS 1148.

9.1.3 Bolts
The bolts are of two types.
   (a) Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets.
   (b) Black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts is adopted. They shall conform to IS 1367.

9.1.4 Electrodes
The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814.

9.2 STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE
The steel work in single section of R.S. Joists, flats, Tees Angles fixed independently with or without connecting plate.

9.2.1 Fabrication
The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

9.2.2 Painting on steel section shall be done as given below
1. All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust.

2. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled.

3. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

9.2.3 Erection
The steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be upto the satisfaction of the Engineer-in-charge.

9.2.4 Measurements

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Steel Section</th>
<th>Tolerance in weight per meter %age</th>
<th>Standard weight as per IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Beams and columns (RS Joists)</td>
<td>(a) Beams - ≤ 200 mm (+)4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) &gt; 200 mm 2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>(ii)</td>
<td>Channels</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>(iii)</td>
<td>Equal and unequal leg Angles</td>
<td>(a) upto 3 mm thickness</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Over 3 mm thickness</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Tee bars</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) Web thickness upto 3 mm</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Web thickness above 3 mm</td>
<td>2.5</td>
</tr>
<tr>
<td>(V)</td>
<td>Bulb angles</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>(vi)</td>
<td>Bars in straight length</td>
<td>Upto and including 10 mm</td>
<td>7</td>
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<tr>
<td></td>
<td></td>
<td>Over 10 mm and upto and including 16 mm</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 16 mm</td>
<td>3</td>
</tr>
<tr>
<td>(vii)</td>
<td>Bars in coils</td>
<td>Weight tolerance is not applicable</td>
<td></td>
</tr>
<tr>
<td>(viii)</td>
<td>Flats</td>
<td>Upto 3 mm thickness</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 3 mm thickness</td>
<td>5</td>
</tr>
<tr>
<td>(ix)</td>
<td>Plates</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>(X)</td>
<td>Strips</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>(xi)</td>
<td>Sheets</td>
<td>Consignment in straight length</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) upto 5 tons</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Above 5 tons</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thickness</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over in mm</td>
<td>1.25mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Upto and including in mm</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tolerance on calculated weight %</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS 1730</td>
<td></td>
</tr>
</tbody>
</table>

| 235 |
Measurements shall be done as given below:

1. The work as fixed in place shall be measured in running meters correct to a millimeter and weights calculated on the basis of standard tables correct to the nearest kilogram.
2. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight shall be as per Table 9.3.
3. Steel sections shall be acceptable within tolerance limits.
4. Payment for steel sections shall be made as per actual weight within tolerances.
5. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only.
6. Steel sections having weight variations lower side than permissible variation shall not be acceptable.
7. Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gussets (taking overall square dimension) fish plates, etc. shall be added to the weight of respective items.
8. In riveted work allowance is to be made for weight of rivet heads.
9. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures.
10. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.
11. The weight of steel sheets, plates and strips shall be taken from relevant Indian standards based on 7.85 Kg/m² for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

9.2.5 Rate
Rate includes the cost of labour and materials required for all the operations described above.

9.3 STEEL WORK IN BUILT UP SECTIONS (RIVETED AND BOLTED)
The steel work in built up section (Riveted and bolted) such as trusses, framed work etc. is specified in this clause.

9.3.1 Laying Out
The steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

9.3.2 Fabrication for built up section:-
General 9.3.2.0
Fabrication shall be done as specified in IS 800. In major works or if so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details or rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge. Accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints.

Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location.

Method:-
9.3.2.1 The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No two pieces shall be welded or joined to make up for the required length of member.

9.3.2.2 Making Holes : Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.
9.3.2.3 Rivet Holes: The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25 mm and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process. Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

9.3.2.4 Assembly: Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of the ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members requiring contact for stress transmission shall be accurately, machined and close butted over the whole section, in column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining. The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

9.3.2.5 Riveting: Rivets shall be used, where slip under load has to be avoided.  
9.3.2.5.1 Preliminaries before Riveting:- Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

9.3.2.5.2 Process of Riveting: The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in-charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than 10mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly. All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets.

All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

9.3.2.5.3 Bolting: The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly. Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two
thread, in all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring washers as directed by the Engineer-in-charge.

9.3.3 Erection
Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

9.3.3.1 The work of erection may be done in suitable units as may be directed by the Engineer-in-charge. Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over turning or collapse by suitable means. During execution, the steel members shall be securely bolted or otherwise fastened when necessary temporarily braced to provide for all loads including those due to erection equipments and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

9.3.3.2 Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

9.3.3.3 Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

9.3.3.4 Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment. The timer mould shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a slopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

9.3.3.5 Bedding of Column, Stanchions etc.- Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoreyed buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made upto 25 mm which shall be pressure grouted with cement grouts. With small columns, if permitted by the Engineer-in-charge, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 10 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

9.3.4 Painting
Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified in para 9.2.2.
9.3.5 Measurements
The work as fixed in position shall be measured in running meters correct to a millimeter and their weight calculated on the basis of standard tables correct to the nearest kilogram.

The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 9.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable.

Unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivet heads. Unless otherwise specified and addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m².

The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

9.3.6 Rate
The rate shall include the cost of all materials and labour involved in all the operation described above.

9.4 STEEL WORK IN BUILT UP SECTION (WELDED)
The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

9.4.1 Laying out: It shall be as specified in para 9.3.1.

9.4.2 Fabrication
Straightening, shaping to form, cutting and assembling, shall be as per para 9.3.2 as far as applicable, except that the words "riveted or bolted" shall be read as "welded" and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

9.4.2.1 Welding: Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where public electricity is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only by resorted to using oxyacetylene flame with specific approval of the Engineer-in-charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813 - 1961.

As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. The surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

9.4.2.2 Precautions: All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

9.4.2.3 Operation, Workmanship and process of Welding shall be as below :-
(a) The work shall be positioned for downward welding wherever possible.
(b) Arc length voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work. The welding current and electrode sizes for different types of joints shall be as per IS 9595.

(c) The sequence of welding shall be such as will avoid undue distortion and minimize residual shrinkage stresses. Recommendation of IS 9595 shall be followed.

Process of Welding

The electrode manipulation during welding shall be such as to ensure that:

1. The parent metal is in a fused stage when the filler metal makes contact with it.
2. The weld metal does not overflow upon any unfused parent metal forming overlapping.
3. The parent metal is not under-cut along the weld toes.
4. The flowing metal floats, the slag, the oxides, and the gas bubbles to the surface behind the advancing pool. In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed.

Each time the arc is started the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run, the arc shall be restarted ahead of the previous deposit and then move back to fill the crater or such alternative technique shall be used as will ensure complete filling of the crater, or complete fusion between the new and old deposit and the base metal at the point of junction, and result in continuity of weld. Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary, and the deposit and the adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers, but also to successive beads, and to the overlapping area wherever a Junction is made on starting a new electrode.

5. The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size (ii) over-size, (iii) under-cutting and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and rewelded.

In case of welded butt joints in steel of thickness upto 50mm the weld joint shall be subjected to radiographic examination as described in IS 1182.

All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done. The surface to be painted shall be cleaned of spatter, rust, loose scale, oil and dirt.

9.4.2.4 Inspection and testing of welds shall be as per IS 822.

9.4.2.5 Assembly : Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance.

9.4.2.6 Erection : The specification shall be as described in para 9.3.3 except that while erecting a welded 'structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible, The gap due to faulty workmanship or incorrect fit if any shall not exceed 1.5...
mm. If gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

9.4.2.7 Painting : Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified in para 9.2.2.

9.4.3 Measurements
The mode of measurements shall be the same as specified in para 9.2.4 except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

9.4.4 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.

9.5 COLLAPSIBLE STEEL GATES
9.5.1 These gates shall be of approved manufacture. The collapsible steel gates shall be fabricated from the mild steel sections as given below.
   a. The gates shall consist of double or single collapsible gate depending on the size of the opening.
   b. collapsible steel gates shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T - iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified.
   c. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.
   d. The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles.
   e. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

9.5.2 Fixing collapsible steel gates:-
Fixing collapsible steel gates shall be done as given below.
   a. T- iron rails shall be fixed to the floor and to the lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel.
   b. The anchor bolts shall be placed approximately at 45 cm centres alternatively in the two flanges of the T- iron.
   c. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose.
   d. The collapsible shutter shall be fixed at sides by fixing the end double channel with T-iron rails and also by hold- fals bolted to the end double channel and fixed in masonry of the side walls on the other side.
   e. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

9.5.3 Painting collapsible steel gates
All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer conforming to IS 2074 before fixing them in position.

9.5.4 Measurements collapsible steel gates
The height and breadth collapsible steel gate shall be measured correct to a cm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the end fixed double channels in open position, of the gate. The area shall be calculated in square meters, correct to two places of decimal.

9.5.5 Rate
The rate shall include the cost of materials and labour involved in all the operations described above.

9.6 M.S. SHEET SLIDING SHUTTER
M.S. Sheet sliding shutter shall be manufactured as per drawings & specification. And fabricated from mild steel sheets.
9.6.1 Fabrication:- Fabrication of M.S. sliding shutter shall be done as given below.
a. The shutters shall be double or single leaf shutter as specified.
b. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted / welded together with 3mm gusset plate at junction to form a rigid frame.
c. M.S. sheet of 1 mm thickness or as specified shall be fixed to the frame with rivets/welds as approved by the Engineer-in-charge. These shall also be provided with top and bottom guide rails of specified size angles or T- irons and 25 mm diameter pulley or with 25 mm diameter ball bearing at the bottom and guide block with steel pulleys at the top.
d. The shutters shall also be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of the item.
e. The guide rails shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can rest against the walls, giving full opening when so required.

9.6.2 Fixing: -
Fixing shall be done as given below.
The guide rails shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitable fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

All the adjoining work damaged in fixing shall be made good to match the existing work.

9.6.3 Painting
All members of the sliding shutters including fittings shall be thoroughly cleaned of rust, scales, dust etc. and given a priming coat of approved steel primer i.e. Red oxide zinc chrome primer conforming to IS 2074 before fixing them in position.

9.6.4 Measurements
The height and width shall be measured correct to a cm and its area for payment shall be calculated in square meters correct to two places of decimal. The height of the shutter shall be measured from outside to outside of the guide rail and width out side to out side of the shutter including the vertical position channels in sides, when shutter closed.

9.6.5 Rate
The rate shall include the cost of materials and labour involved in all the operation described above. It also includes the cost of the full length of guide rails. -

9.7 M.S. SHEET SHUTTERS / GARRAGE DOORS
These shall be manufactured as per drawing and specification. These shall be fabricated from mild steel sheets and, angle iron.

9.7.1 Fabrication:-
Fabrication shall be done as given below.
a. The doors shall be provided as double leaf shutters unless otherwise specified. The shutters shall be fabricated with frame of M.S. angle 40 x 40 x 6 mm @ 3.5 kg/ meter and two diagonal braces of the same section unless otherwise specified. The frame shall be riveted and/ or welded at the junctions.
b. Wherever riveting shall be done 3.15 mm (10 G) thick gusset plate shall be provided at the junction.
M.S. sheet of 1 mm thickness or as specified, shall be fixed to the frame with rivets or welds as approved by the Engineer-in-charge. Alternatively the diagonal bracing may be replaced by one horizontal and two cross flats 30 x 6 mm unless otherwise specified.
c. The outer frame shall be provided with cleats made of section 40 x 10 mm and bent in the shape of angle cleats with one arm 150 mm long and the other arm 50 mm long and fixed to the angle iron frame of the door with two 12 mm dia bolts and nuts. For doors upto 2.40 m height, two angles cleats per door shall be provided.
d. The cleat shall have a vertical leg of 150 mm which shall be fixed with frame and horizontal leg of about 50 mm which shall be provided with a hole of 24 mm dia and fixed in the projected pin of the pin clamp.
9.7.2 Fittings and Fixtures
Shutters shall be fixed to the wall masonry with four pin clamps (pintles) where the height of the shutter is upto 2.4 m. Each pin clamp shall consist of 50 x 6 mm flat iron 45 cm long bent and forked at one end and provided with 20 mm diameter M.S. pin on the other. The pin shall be firmly riveted or welded to the pin clamp, the other end of which shall be embedded in masonry by means of cement concrete block 40 x 20 x 20 cm of 1:3:6 mix (1 cement :3 coarse sand:6 graded stone aggregate 20 mm nominal size). It shall be so placed that bottom pin shall face upwards and “top pin downward” in order that the gate may not be removed by lifting over pins.

One hook with eye 45 cm long of 10 mm diameter shall be provided for each shutter to keep it fixed in open position. The hook shall be fixed in wall masonry with wooden block and the eye shall be fixed on 6 mm thick M.S. plate as staple and fixed in the shutter frame with rivet or weld.

A cement concrete block 15 x 10 x 20 cm in 1:2:4 (1 cement:2 coarse sand:4 grades stone aggregate of 20 mm nominal size) mix shall be embedded in the floor or at junction of two shutters so that door shutter open only on the outside and not on the inside. The shutters shall also be provided with locking arrangement and two handles of the shape and pattern as approved by the Engineer-in-charge.

9.7.3 Painting
All the members of the door including angle iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer i.e. Red Oxide/ Zinc chrome primer confirming to IS 2074 before fixing them in position.

9.7.4 Measurements
The width and height of shutters shall be measured to the nearest cm. The area shall be calculated in square meter correct to two places of decimal.

9.7.5 Rate
All the rate shall include the cost of materials and labour involved in all the operation described above. Nothing extra shall be paid for cement concrete block or wooden blocks nor anything deducted for these from the measurement of the masonry wall.

9.8 ROLLING SHUTTER:-
Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters up to 10 sq. meter shall be of push and pull type and shutters with an area of over 10 sq meter shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

9.8.1. Shutter: The shutter shall be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90 mm for the shutters up to 3.5 m width. Shutters above 9 meters width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

9.8.1.1 Spring : The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part-1.

9.8.1.2 Roffer and Brackets : The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter up to 6 meter width and height not exceeding 5 meter, steel pipes of 50 mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters up to a door height of 3.5 meter. The size of mild steel brackets shall
be 500 x 500 x 10 mm for shutters of clear height above 3.5 m and upto 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall be connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

9.8.1.3 When the width of the opening is greater than 3.5 mtr. The cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearing with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.

9.8.1.4 In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

9.8.1.5 Guide Channel : The width of guide channel shall be 25 mm the minimum depth of guide channels shall be as follows:

<table>
<thead>
<tr>
<th>Clear width of shutters</th>
<th>Depth of guide channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 3.5 m</td>
<td>65 mm</td>
</tr>
<tr>
<td>3.5 m upto 8 m</td>
<td>75 mm</td>
</tr>
<tr>
<td>8 m and above</td>
<td>100mm</td>
</tr>
</tbody>
</table>

9.8.1.6 The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

9.8.1.7 Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

9.8.1.8 The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

9.8.1.9 Cover : Top cover shall be of mild steel sheets not less than 0.90 mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

9.8.1.10 Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

9.8.2 Fixing
The arrangement for fixing in different situations in the opening shall be as per IS 6248.

9.8.2.1 Brackets shall be fixed on the lintel or under the lintel as specified with rawl plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

9.8.2.2 The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in a workmen like manner that the operation of the shutter is easy and smooth.

9.8.3 Measurements
Clear width and clear height of the opening for rolling shutter shall be measured correct to a mm. The clear distance between the two jambs of the opening shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height. The area shall be calculated in square meters correct to two places of decimal.
9.8.4 Rate
The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.

9.9 ROLLING GRILLS-SHUTTERS:-

9.9.0 Purpose:-
- a. Purpose for which rolling grills shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter.
- b. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter.

Note: - The total height of the grill portion in all the segments of rolling shutter-cum-grill shall not exceed 1.0 m and the height of the grill portion in any individual segment shall not be more than 0.5 m.

9.9.1 Design, construction and operation:-
Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 9.8 shall be applicable to rolling grills shutters except in respect of the shutter portion, and shall conform to IS 6248.

9.9.2 Rolling grills shutter fabrication:-
Fabrication of rolling grill shutter and the rolling grill portion of the rolling shutter-cum-grill shall be done with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20 mm wide and 5 mm thick mild steel flat links. Straight bars shall be spaced not more than 150 mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120 mm and the depth of corrugation is 80 to 100 mm. or as directed by engineer in charge, all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes in the length of the links shall be such that the distance from the centre of the hole to the nearest edge if the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughs of the bars bent to the squired profile. Each bar and link shall be continuous single piece without any joint.

9.9.3 Measurement & Rate
The measurement and rate shall be as specified in 9.8.3 and 9.8.4 respectively. In case of rolling shutter-cum-grill, where the area of the grill portion is half or less than half the area of opening, it shall be measured and paid as rolling shutter and where the area of grill portion is more than half the area of opening, it shall be measured and paid as rolling grill.

9.10 STEEL DOORS, WINDOWS, VENTILATORS AND COMPOSITE UNITS
The hot rolled steel sections for fabrication of steel doors, windows, ventilators and fixed lights shall conform to IS 7452. Shapes weights and designations of hot rolled sections shall be as per IS 7452. The fabricated steel doors, windows, ventilators and composite units shall confirm to IS 1038 with up-to-date amendments and shall be IS marked (IS 1038).

Tolerance: - Tolerance in the thickness of the section shall be ± 0.2 mm

Weights and designation of MS rolled steel section are given below:-

<table>
<thead>
<tr>
<th>Designation</th>
<th>Wt Kg/m</th>
<th>Situation of Use of Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>1.036</td>
<td>Vertical and horizontal glazing bars for doors and shashes : window, ventilators glazing bars for door side lights sub dividing bars for fixed length, sash bars for doors, windows and ventilators wheel steel aluminium or wooden beading is used for fixing glasses.</td>
</tr>
</tbody>
</table>
Designation | Wt Kg/m | Situation of Use of Section
--- | --- | ---
T3 | 1.14 | Vertical glazing bars for FZ 7 frame
T6 | 0.839 | Vertical and horizontal glazing bar for standard windows and ventilators.
F2 | 1.46 | Inner frames for open-in windows
F3 | 2.28 | Outer frames for open-in windows
F5 | 1.55 | (a) Inner and middle frames in centre-hung ventilators
(b) F5 is some time used as inner frames for open-out windows. Also used as inner frame for bottom hung ventilators.
(c) F8 is also used as outer frame for bottom hung ventilators.
F4B | 2.28 | Central mullion (meeting bar for shutters) for windows and ventilators using F7D as inner frames, outer frames for open-in windows in rainy areas, sub dividing bars for openable windows and top-hung ventilators.
F7D | 1.419 | Inner and outer frames for windows and top hung Ventilators, for inner frames for centre-hung ventilators and outer frames for door sidelights.
FX6 | 2.52 | Inner frame for doors
FZ7 | 1.90 | Used as outer frame for industrial shashes. Also used for outer frame and wooden doors.
FX8 | 2.31 | Outer frames for doors
FZ5 | 2.52 | Inner frames for doors
F11B | 1.80 | (a) Vertical coupling mullion for standard windows
(b) Can be used as horizontal coupling bar when openable windows are to be coupled above fixed ones or between two fixed windows.
(c) Can also be used as horizontal coupling mullion where windows are not exposed to weather.
F12B | 2.30 | Horizontal coupling mullion, also known as weather bar, Especially used when the coupled unit is exposed to rain.

9.10.1 Size:--The steel doors and windows shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening allow for easy fitting of doors windows and ventilators into opening. The actual sizes of doors, windows and ventilators shall not vary by more than + 1.5 mm from those given in the drawing.

9.10.2 Fabrication of steel door, window, ventilator and composite unit:--

9.10.2.1. Frames:-- Frames shall be made as given below.
Both the fixed and openable frames shall be made of sections which have been cut to length and mitred. The corner of fixed and openable frames shall be welded to form a solid fused sided joint conforming the requirements given below in Para 9.10.2.2. All frames shall be square and flat. The welding process adopted shall be “flush but welding” or can be any other process as agreed to between the supplier and the purchaser which shall fulfil the requirements given in clause 6.1.1 of IS 1038, metal arc welding or any other suitable method. The section for glazing shall be tenoned and riveted into the
frames and where they intersect the vertical tie shall be broached and horizontal tee threads through it, and the intersection closed by hydraulic pressure.

9.10.2.2 Requirements of Welded Joints

(i) Visual Inspection Test: When two opposite corners of the frame are cut, paint removed and inspected, the joint shall conform to the following:
   (a) Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.
   (b) Welds should have been properly grounded and
   (c) complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.

(ii) Micro and Macro Examinations: From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and cavity and reasonably free from under cutting overlaps, gross porosity and entrapped slag.

(iii) Fillet Weld Test: The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

9.10.2.3 Doors: The hinges for the doors shall be of 50mm projecting type. Non projecting type hinges may also be used, if approved by Engineer-in-Charges. The hinge pin shall be electro-galvanized steel or aluminum alloy of suitable thickness and size. Door handles shall be approved by the Engineer-in-Charge. A suitable latch lock for door openable both from inside and outside shall be provided.

In the case of double doors, the first closing leaf shall be the left hand leaf locking at the door from the push side. The first closing shutter shall have a concealed steel bolt at top and bottom. The bolts shall be so constructed as not to work loose or drop by its own weight.

Single and double leaf shutter door may be provided with a three way bolting device. Where the device is provided in the case of double leaf shutters, concealed brass or steel bolts shall not be provided.

9.10.2.4 Windows Generally there are two type of window.
   1. Fixed window.
   2. Side hung window.
   (a) For fixed windows, the frames shall be fabricated as per Para 9.10.2.1
   (b) Side hung windows: For fixing of steel hinges in side hung window, slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame at the back. The hinges shall be of projecting type with thickness not less than 3.15 mm and length not less than 65 mm and width not more than 25mm. Non projecting type hinges may also be allowed if approved by the Engineer-in-Charge. The diameter of hinge pins shall not be less than 6mm. The hinge pin and washer shall be of galvanized steel or aluminum alloy of suitable thickness.

For fixing hinges to inside frame, the method described above may be adopted but the weld shall be cleaned, or the holes made in the inside frame and hinge riveted. The handle of side hung shutters shall be pressed brass, cast brass, aluminium or steel protected against rusting and shall be mounted on a steel plate. Thickness of handle shall not be less than 3mm in case of steel or brass and 3.5mm in case of aluminium. The handle plate shall be welded, screwed and/or rivetted to the opening frame in such a manner that it should be fixed before the shutter is glazed and should not be easily removable after glazing.

The handle shall have a two point nose which shall engage with a brass or aluminium alloy striking plate on the fixed frame in a slightly opened position as well as closed position. The boss of handle shall incorporate a friction device to prevent the handle from dropping under its own weight and the assembly shall be so designed that the rotation of the handle may not cause it to unscrew from the pin.

The height of the handle plate in each type of standards windows will be as specified, otherwise it shall be at a height of 3/8 of the height of shutter, from its bottom. The strike plate shall be so designed and
fixed in such a position in relation to the handle that with the later bearing against its stop, there shall be adequately tight fit between the casement and outer frames.

In case where no friction type hinges are provided, the windows shall be fitted with peg stays which shall be either of black oxidised steel, pressed or cast brass or as specified, 300 mm long or as specified with steel peg and locking brackets. The pegs stay shall have three holes to open the side hung casement in three different angles. The peg stay shall be of minimum thickness 2 mm in case of brass or aluminium and 1.25 mm in case of steel. Where specified friction hinges shall be provided Side hung shutters fitted with friction hinges shall not be provided with a peg stay. If specified, side hung shutters may be fitted with an internal removable fly proof screen in a 1.25 mm thick sheet steel frame to the outer frame of the shutter by brass turn buckles at the jambs, and brass studs at the sill to allow the screen being readily removed. The windows with removable fly proof screen shall be fitted with a through the screen level operator at the sill level to permit the operation of the shutter through an angle of 90° without having to remove the fly proof screen. The lever shall permit keeping the shutter open in minimum three different positions.

9.10.2.5 Ventilators
(a) Top Hung ventilators:-
The steel butt hinges for top hung ventilators shall be riveted to the fixed frame or welded to it at the back after cutting a slot in it. Hinges to the opening frame shall be riveted or welded Top hung ventilators shall be provided with a peg stay with three holes which when closed shall be held tightly by the locking bracket. The locking bracket shall either be fitted to the fixed frames or to the window.

(b) Centre Hung Ventilators
Central hung ventilators shall be hung on two pairs of brass or aluminium cup pivots as specified, riveted to the inner and outer frames of ventilators to permit the ventilator shutter to swing to angle of approximately 85°. The opening portion of the ventilators shall be so balanced that it remains open at any desired angle under normal weather conditions.

9.10.2.5.1 A black oxidised steel spring catch approved by the Engineer-in-Charge shall be fitted in the centre of the top of the centre hung ventilator, for the operation of ventilators. The spring catch shall be secured to the frame with M.S. screws and shall close into a mild steel or malleable iron catch plate riveted, screwed or welded to the outside of the outer window frame bar.

9.10.2.5.2 A black oxidised cord pulley wheel in galvanized mild steel brackets shall be fitted at sill of the centre hung window with mild steel screws or alternatively welded together with mild steel or malleable iron cord-eye riveted or welded to the bottom inner frame bar of the window in a position corresponding to that of pulley.

9.10.2.5.3 Composite Units: Composite Units consist of a combination of two or more units of doors, windows and ventilators etc. as the case may be. The different units shall be coupled by using suitable coupling sections as the case may be. Wherever the ventilators, windows and doors shall be coupled with a coupling sections, mastic cement shall be applied between the junction to make the Joint water tight.

9.10.3 Glazing
The Specifications described in Chapter 8 of Para 8.5.4.f shall apply. The glass panes shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. In doors, windows and clerestory windows of bath, WC and lavatories frosted glass panes shall be used which shall weight not less than 10.00 kg/m².

9.10.3.1 Glazing shall be provided on the outside of the frame unless otherwise specified. Putty of approved make conforming to IS 419 shall be used for fixing glass panes. Putty shall be applied between glass panes and glazing bars. Putty shall then be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the back rebate to enable the painting to be done up to the sight line to seal the edge of the putty to the glass. The oozed out putty shall be cleaned and from putty cut to straight line. Quantity of putty shall not be less than 185 gm/ meter of glass per meter. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its cracking.
Note: Putty may be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to the 18 kg paste.

9.10.3.2 Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note: Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

9.10.3.3 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading. Size of M.S. bead shall be 10 x 10 mm box section manufactured from 1.6 mm thick sheet unless otherwise specified in the item. Where metal beading is specified, extra payment shall be made on this account.

9.10.4 Finishing
All steel surfaces shall be thoroughly cleaned of rust, scale and dirt. Where so specified, the steel surface shall be treated for rust proofing by the hot dip, zinc spray or electro galvanizing process. A priming coat of approved steel primer i.e. red oxide/ zinc chromate primer conforming to IS 2074 shall be given. The fabricated steel door, windows, ventilators and composite units shall be inspected in the factory and approved by the Engineer-in-charge before priming coat is applied. Final finishing coat shall be given to the doors, windows and ventilators after they are erected and fixed in final position. The rate shall be exclusive of final finishing coats but shall include the priming coat.

9.10.5 Fixing
9.10.5.1 Steel, doors and windows shall be so stacked as to keep them in true shape without damage. Doors, windows and ventilators shall be fixed as described below.

9.10.5.2 Opening may be flush or rebated as shown in the drawing. The opening may have rendered finish or a "fair faced" finish (i.e. without rendering as in case of marble or stone facing). Where openings are flush and with a rendered finish a clearance of 1.25 cm shall be provided between the steel frame and opening. In case of external masonry finish "fair faced" and with rebated Jambs, a minimum 1.25 cm clearance between frame and opening shall provided opening in steel work shall be so designed that the outer flange of the door, windows., or ventilator frame section overlaps the steel surface by 10 mm.

Note; The sizes of Indian Standard doors, windows and ventilators, are designed for modular opening 1.25 cm larger all round than the doors, windows etc. This gap of 1.25 cm is for the purpose of fixing of doors, windows etc. In masonry opening, the gap is filled up with mastic cement and plaster after the door or windows is fixed in position. In the case of steel or timber modular opening, extra steel or timber fillets will be necessary to cover this gap of 1.25 cm.

9.10.5.3 Fixing in Masonry Openings
(a) Fixing with Lugs
(i) Doors, windows and ventilators unit, shall not be "built in" as the work proceeds but opening shall be left out and frames fitted afterwards so that the minimum specified clearance between opening and unit frame is left around. The size of the opening shall first be checked and cleared of obstruction, if any. The position of the unit and fixing holes shall be marked on the jamb. Necessary holes shall be made in the masonry and lugs not less than 10 cm long 15x3 mm size M.S flat fixed in cement concrete blocks 15 x 10 x 10 cm size of 1:3:6 mix (1 cement : 3 coarse sand:6 graded stone aggregate 20mm nominal size). The frames of units shall be set in the opening by using wooden wedges at the Jamb, head and sill, (wedges shall preferably be placed near the points where a glazing bar meets the frames and be plumbed in position).
(ii) After, the frame shall be fixed with the lugs with 20 mm long and 6.3 mm dia. G.I. counter sunk machine screws and nuts. In case of flush opening which are rendered smooth, wedges shall be removed and gap between unit and the jambs shall be filled with cement mortar.

(iii) In case of flush jamb with external “fair faced” finish the gap between the opening and frame shall be filled with mastic from inside till it oozed out on eternal face. The oozing mastic shall be cleaned and flush pointed. The internal gap shall be filled with mastic to about 1/3rd depth the rest with cement mortar.

(iv) In case of rebated jambs and Jambs finished "fair faced" externally, the mastic shall be freely applied to the inside channel of frame, jamb and sill, so as to ensure a watertight Joint. After the units is firmly fixed in position surplus mastic shall be cleaned and flush pointed.

(b) Fixing with Screws and Plugs: In R.C.C. work where lugs cannot be embedded due to reinforcement bars etc. rawl plugs or other approved metallic fasteners may be fixed in proper position and frame fixed to them with 60 mm galvanized cross recessed head wood screws of designation 10.

9.10.5.4 Fixing in Wood Work Opening: Opening in wood work are normally rebated and approved mastic or rubber linings shall be applied to jambs, sill and channel before fixing in position, the frame shall be set in opening using wooden wedges as specified in Para 9.10.5.3 and fixed to the opening with 60 mm galvanized wood screws of designation 10. Extra timber fillets of hard wood to match the adjoining work shall also be provided around the frame to close the extra gap between opening and frame.

9.10.5.5 Fixing in Steel Work Opening: Before placing the unit frame in position approved mastic shall be applied as specified in 9.10.5.3 (a) (iv) and a mild steel or hard wood fillet shall be provided around the frame to close the extra gap between opening and frame. The unit shall then be fixed to the opening with fixing dips or with nuts and bolts as shown in the drawings or as directed by the Engineer-in-Charge.

9.10.5.6 Fixing of Composite Units: The fixing procedure for composite units shall generally be as described under 9.10.5.1 to 9.10.5.5 except that.

Where large units shall be formed by coupling individual units together (with coupling sections), the mullions and transom shall be bedded in mastic to ensure water tightness, Mastic shall be applied liberally to the channels of the outside frame section before assembly and after coupling. All oozing but mastic shall be cut out neatly.

9.10.6 Precautions
Care shall be taken that steel doors and windows etc. are not deformed/ damaged during subsequent constructions. Particular care shall be taken that scaffolding do not rest on the steel door window frames or glazing bars. All fittings and hinges (projecting hinges) shall be protected, preferably with alkathene sheets so that these may not be damaged during execution of work.

9.10.7 Measurement
The weight of finished section door/windows of different sizes, inclusive of all fixed /welded fittings i.e. hinges pivots, lugs, brackets striking plates etc., shall be worked out before fixing of windows (exclusive of weight of glass panes, glazing clips, putty etc.). Sectional weight of steel members only shall be measured without weight of glass panes etc. Any loose fittings such as casement stays/fasteners etc. shall be enumerated and paid for separately.

9.10.8 Rate
Rate shall include the cost of materials and labour involved in all the operations described above excluding two coats of painting but including cost of glazing and priming including the cost of projecting hinges in case of side hung doors/windows, plain hinges in case of top/ bottom hung windows / ventilators and pivots for centre hung windows/ ventilators.
Metal beading and other fittings such as peg stay and casement window fasteners etc. shall be enumerated and paid for separately.

9.11 T-IRON DOORS, WINDOWS AND VENTILATORS FRAMES.
T-iron doors, windows and ventilators frames shall be manufactured from uniform mild steel Tee section. The steel shall be of the grade as provided in 9.1.1 the frames shall be got fabricated in approved workshop.

9.11.1 The sizes of doors, windows and ventilator frames shall be as per drawing or as decided by the Engineer-in-Charge. MS tie bar of 10 mm dia. shall be welded at bottom of the frame. The size of doors, window and ventilators shall be calculated so as to allow 12.5 mm clearance on all sides to allow an easy fittings in opening. The actual size of doors, windows and ventilator shall not vary by more than ±2 mm than those shown in the drawings.

The size of T section used for manufacture of doors, windows and ventilators shall not be less than those specified in IS 1038 unless otherwise directed by the Engineer-in-charge.

9.11.2 Fabrications
The frame shall be constructed in section which has been cut to length and mitred. The corners of the frames shall be butt welded to form a true and right angle. All frames shall be square and flat meeting the requirements stated under para 9.10.2.1.1.

The T Sections shall be mitre joined and continuously butt welded all along. The requirement of welded joints shall be as specified under para 9.10.2.2.

9.11.3 Fittings
Requisite number of holes shall be made in the frame for fixing of fitting. All fitting shall be fillet welded to T-iron frame all along the periphery of contact.

Butt hinges shall be fixed to the frame as below:
(i) MS flat of size 100 mm x 25 mm x 6 mm will be welded with fillet weld all along the periphery of contact on the rear side of the web of T iron to receive the hinges. Requisite number of holes shall be made in T iron frame and MS flat for fixing of hinges with counter sunk steel screws (ii) An alternate method of fixing butt hinges can be adopted by fillet welding the hinge to the T iron frame on three sided. No welding shall be done along the hinge pin to allow free movement of butt hinges.

9.11.4 Fixing Procedure
Fixing procedure for T iron doors, windows and ventilator frames in masonry opening shall be as described in 9.10.5.

9.11.5 Measurements
T-iron door windows and ventilator frames shall be measured in running meter, along the centre line of the frame correct to a 1mm and weight calculated on the basis of standard tables. No deduction or extra payment shall be made for making holes and making arrangement for fixing fittings including packing wherever necessary. No deduction will be made for not providing tie bars in case of windows and ventilators.

9.11.6 Rate
The rate includes cost of materials and labour involved in all the operation described above. It shall include the necessary butt hinges and screws for fixing the same with frame or as specified. But it does not include the cost of other door, window and ventilator fittings.

9.12 PRESSED STEEL DOOR FRAMES
9.12.1 Materials
Steel door frames shall be manufactured from commercial mild steel sheet of specified thickness, conforming to IS 2062 and 4351. Steel door frames with or without fan light shall be made in the profiles
which may be manufactured to suit doors of either type opening inwards or outwards as directed by the Engineer-in-Charge.

9.12.2 Construction
Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold. These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be of pressed mild steel 1.25 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable , or alternatively, threshold of mild steel angle of section 50 x 25 mm, minimum shall be provided for external doors frames,

9.12.3 Fabrication
The pressed steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

9.12.3.1 Fixing Lugs: There shall be three adjustable lugs with split end tail to each jamb without fan light, and four for jamb with fan light. The head of the fixing lug shall be of one of the following lengths:
(a) 98 mm long for use with profile A
(b) 120 mm long for use with profile B
(c) 160 mm long for use with profile C

The head shall be made from flat steel strip 25 mm wide and not less than 1.60 mm thick. The tail of the lugs shall be 200mm long and shall be made of steel strip not less than 40 mm wide and not less than 1 mm thick.

9.12.3.2 Hinges 100 mm mild steel butt hinges shall be used. For door frames 80 cm wide and under, three hinges shall be rigidly fixed to one jamb and for door frames above 80 cm wide, four hinges shall rigidly fixed to one jamb, if it is single shutter, where the height of door shutter exceeds 2.15 meters, one additional hinge shall be provided for every 0.5 m or part thereof the additional height.

In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distances from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take No. 10 cross recessed head wood screws.

9.12.3.3 Mortar Guards: Mortar guards of thickness of main frame sheet shall be provided in accordance to provisions of IS 4351 and as instructed by Engineer-in-charge shall be provided. These shall be welded to the frame at the head of the frame for double shutter doors to make provision for bolts. These shall also be provided to the frame behind the hinges, mortice locks and latches, slots, aldrop and sliding /tower bolts.

9.12.3.4 Lock Strike Plate: There shall be an adjustable lock- strike plate of steel complete with mortar guard to make provision for locks or latches complying with the relevant Indian Standards. (IS 4351) Lock-strike plates shall be of galvanized mild steel and fixed at 95 cm from the head of the frame.

9.12.3.5 Shock Absorbers: For side hung door there shall not be less than three buffers or rubber or other suitable material inserted in holes in the rebate, one shall be located at the centre of the lock jamb and the other two shall be at 30 cm. from top and bottom of the frame. For double leaf shutter door, two buffers shall be provided.

9.12.4 Finishing
The surface of door frame shall be thoroughly cleaned, free of rust, mill-scale dirt oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as picking. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming to IS 2074. Two coats of paints as directed by the Engineer-in-charge shall be applied to the exposed surface.
9.12.5 Fixing
Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame.

Three lugs shall be provided on each jamb with spacing not more than 75 cm. The temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface, one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

9.12.6 Measurements
The length shall be measured in running meter correct to a cm along the centre line of the frames.

9.12.7 Rate
The rate shall include the cost of labour and material involved in all the operation described above including one coat of approved steel primer but excluding two coats of paint.

9.13 TUBULAR / HOLLOW SECTION TRUSSES
Steel tubler pipes shall be tested in field laboratory by the procedure as in IS 1608 for tensile, IS 2329 for bend and IS 2328 for flattening test. The minimum qty of material taken out for test and frequency of testing shall be every 8 tonne or part thereof. This test are mandatory.

9.13.1 Structural Steel Tube shall be of
1. Hot finished welded (HFW) type,
2. Hot finished seamless (HFS) type,
3. Electric resistance or induction butt welded (EHW), having carbon content less than 0.03%, yield stress of 21.5 kg/mm² (YST210).

Conforming to the requirement of IS 1161. The steel tubes when analysed in accordance with the method specified in IS 228 shall show not more than 0.06% sulphur, and not more than 0.06 per cent phosphorous.

Tubes shall be designated by their nominal bore. These shall be light, medium or heavy as specified depending upon the wall thickness. The standard size and weights of tubes are as below.

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<th>Weight (kg/m)</th>
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L means Light, M means Medium, H means Heavy

Tubes shall be clean finished and reasonably free from scale, free from cracks, surface flaws, laminations and other defects. The ends shall be cut clean and square with axis of tube, unless otherwise specified.

9.13.2 Minimum Thickness of Metals
Wall thickness of tubes used for construction exposed to weather shall be not less than 4 mm and for construction not exposed to weather it shall be not less than 3.2 mm where structures are not readily accessible for maintenance, the minimum thickness shall be 5 mm.

9.13.3 Fabrication
The component parts of the structure shall be assembled in such a manner that they are neither twisted nor otherwise damaged and be so prepared that the specified cambers, if any, are, maintained. The tubular steel work shall be painted with one coat of approved steel primer after fabrication. All fabrication and welding is to be done in an approved workshop. The joint details shall be generally as per S.P-38 of B.I.S publication.

9.13.3.1 Straightening: All material before being assembled shall be straightened, if necessary, unless required to be of curvilinear form and shall be free from twist.

9.13.3.2 Bolting: Washers shall be specially shaped where necessary or other means, used to give the nuts and the heads of bolts a satisfactory bearing. In all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted
together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.

9.13.3.3 **Welding**: Where welding is adopted, it shall be as per IS 816.

9.13.3.4 **Caps and Bases for Columns**: The ends of all the tubes, for columns transmitting loads through the ends, should be true and square to the axis of the tubes and should be provided with a cap or base accurately fitted to the end of the tube and screwed, welded or shrunk on. The cap or base plate should be true and square to the axis of the column.

9.13.3.5 **Sealing of Tubes**: When the end of a tube is not automatically sealed by virtue of its connection be welding to another member the end shall be properly and completely sealed. Before sealing, the inside of the tubes should be dry and free from loose scale.

9.13.3.6 **Flattened Ends**: In tubular construction the ends of tubes may be flattened or otherwise formed to provide for welded. Riveted or bolted connections provide that the methods adopted for such flattening do not injure the material. The change of sections shall be gradual.

9.13.4 **Hoisting and Erection**

Tubular trusses shall be hoisted and erected in position carefully, without damage to themselves, other structure, equipment and injury to workman. The method of hoisting and erection proposed to be adopted shall be got approved from the Engineer-in-charge. The contractor shall however be fully responsible, for the work being carried out in a safe and proper manner without unduly stressing the various members. Proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

9.13.5 **Measurements**

The work as fixed in place shall be measured in running meters correct to a centimeter on their weights calculated on the basis of standard tables correct to the nearest kilogram unless otherwise specified.

Weight of cleats, brackets, packing pieces bolts nuts, washers distance pieces separators diaphragm gussests (taking overall square dimensions) fish plates, etc. shall be added to the weight of respective items unless otherwise specified. No deduction shall be made for skew cuts.

9.13.6 **Rate**

The rate shall include the cost of labour and materials involved in all the operations described above including application of one coat of approved steel primer i.e. red oxide zinc chrome primer conforming to IS 2074.

9.14 **FAN CLAMPS (Fig. 9.1- A,B,C)**

9.14.1 Types of fan clamps are:-

(a) Fan clamp to be fixed during the laying of R.C.C. slab, shall be of type I, as shown in Fig. 9.1-A given below. This shall be made of 16 mm M.S. bar bent to shape with its ends hooked. The overall height of the clamps shall be made to suit the depth of slab.
(b) Fan clamps for beams shall be of type II as shown in Fig. 9.1-B given below. It shall be similar to fan clamp, type 1, except that its height shall be greater depending on the depth of the beam rib.

(c) In case low ceiling heights, circular cast iron box for ceiling fan clamp shall be fixed during the laying of R.C.C. slab and shall be as shown in Fig. 9.1-C. The size of cast iron box shall be in all cases, where the full area of the bolts is to be developed, the threaded portion of the bolt shall not be within the thickness of the parts bolted together and washers of appropriate thickness shall be provided to allow the nuts to be completely tightened.

9.14.2 Fixing
Holes for inserting the fan clamps in the positions as show in the drawing or as instructed by the Engineer-in-charge shall be made in the shuttering after the latter has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the under-side of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut pieces of M.S. bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed.

The exposed portion of loops of the clamps shall be given two or more coats of paint, including priming coat, of approved steel primer as ordered by the Engineer-in-charge.
9.14.3 Measurements
Clamps of type I and 3 shall be counted in numbers. Fan clamps type II, shall be counted and paid for under fan clamps type I, but they shall in addition be paid for their extra height as determined by the depth of the beam.

9.14.4 Rate
The rate per fan clamps shall include the cost of labour and materials involved in all the operations described above. In the case of type I and 3 clamps, the rate shall apply irrespective of the thickness of the slabs.

9.15 M.S. HOLLOW RECTANGULAR DOOR FRAMES (I-TYPE SECTION)
Steel door frames shall be manufactured from commercial mild steel sheet of 1.60 mm thickness, conforming to IS 2062 and 4351. Steel door frames shall be made in the profiles as per drawings and/or as directed by the Engineer-in-charge.

9.15.1 Construction
Each door frame shall consist of hinge jamb, lock jamb, head and if required angle threshold. These shall be welded or rigidly fixed together by mechanical means. Where no angle threshold is required, temporary base tie shall be screwed to the feet of frames in order to form a rigid unit. Where so specified base ties shall be pressed mild steel 1.60 mm thick adjustable to suit floor thickness of 35 or 40 mm and removable, or alternatively, threshold of mild steel angle of section 50 x 25 mm. minimum shall be provided for external doors frames.

9.15.2 Fabrication
The M.S hollow rectangular steel door frames shall be got fabricated in an approved workshop as approved by the Chief Engineer.

9.15.2.1 Fixing Lugs: There shall be three adjustable lugs with split end tail to each jamb. The head of the fixing lug shall be 120 mm long and made up flat steel strip 25 mm wide and 1.60 mm thick.

9.15.2.2 Hinges 100 mm mild steel butt hinges shall be used. Floor door frames 80 cm wide and under, three hinges shall be rigidly fixed to one Jamb and for frames of door above 80 cm wide, four hinges shall be rigidly fixed to one jamb, if it is single shutter. Where the height of door shutter exceeds 2.15 meters, one additional hinge shall be provided for every 0.5 m or part thereof of the additional height. In all cases the hinges shall be so fixed that the distance from the inside of the head rebate to the top of the upper hinge is 20 cm and the distance from the bottom of the door frame to the bottom of the bottom hinge is also kept about 200 mm. The middle hinges shall be at equal distance from lower and upper hinges or as agreed to between the purchaser and the supplier. Hinges shall be made of steel 2.5 mm thick with zinc coated removable pin of 6 mm diameter. The space between the two leaves of the hinge when closed shall be 3 mm and the leaf that is not welded to the frame shall have four counter sunk holes to take Number-10 cross recessed head wood screws.

9.15.2.3 Aldrops Sliding Bolts and Tower Bolts: Provisions shall be made for aldrops, sliding bolts and tower bolts in the frames as per the positions given by the purchaser. Necessary mortar guards/metalltic or nylon bushes shall be provided inside the frames for aldrops, sliding bolts and tower bolts.

9.15.2.4 Lock Strike Plate: Provision shall be made to fix lock strike plates of mortise locks or latches, complying with the relevant Indian Standards. A slot suitable for lock strike plate shall be pierced into the rebate of the frame and necessary fixing arrangement and mortar guard from the inside of the frame shall be provided.

9.15.2.5 Shock Absorbers: For side-hung door there shall be not less than three buffers of rubber or other suitable material inserted in holes in the rebate and one shall be located at the centre of the lock jamb of frame and other two shall be 300 mm from top and bottom of the frame. For double leaf doors two buffers shall be provided.

9.15.3 Finishing
The surface of door frame shall be thoroughly cleaned, free of rust, mill scale dirt, oil etc. either by mechanical means, for example sand or shot blasting or by chemical means such as pickling. After pretreatment of the surface one coat of approved primer i.e. red oxide zinc chrome primer conforming
to IS 2074. Two coats of paints as directed by the Engineer-in-Charge shall be applied to the exposed surface.

9.15.4 Fixing
Frames shall be fixed up right in plumb and plane. To avoid sag or bow in width during fixing or during construction phase, temporary struts across the width preventing sides bulging inwards may be provided. Wall shall be built solid on each side and grouted at each course to ensure solid contact with frame leaving no voids behind the frame. Three lugs shall be provided on each jamb with spacing not more than 75 cm the temporary struts should not be removed till the masonry behind the frame is set. In case screwed base tie is provided, this should be left in position till the flooring is laid when it can be removed.

After pretreatment of the surface one coat of steel primer and two coats, of paint, as directed by Engineer-in-charge shall be applied to the exposed surface.

9.15.5 Measurements
The length shall be measured in running meter correct to a cm. along the centre line of the frames.

9.15.6 Rate
The rate shall include the cost of labour and material involved in all the operation described above including one coat of approved steel primer but excluding two coats of paint.

9.16 FACTORY MADE GLAZED STEEL DOORS, WINDOWS AND VENTILATORS
Specifications for this item to be same as for standard steel glazed doors, windows and ventilators as mentioned in para 9.10, except that doors, windows and ventilators to be manufactured in a workshop, approved by the Chief engineer. Also -owner of the workshop shall have a valid ISI license for manufacture of doors, windows and ventilators.

9.17 STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL
(A) In Stringers, Treads, Landing etc. of Stair cases including use of Chequred Plate wherever required
(B) In Grating. Frames, Guard Bar, Ladder, Railings, Brackete, Gates and similar work.

9.17.1 General specifications for these items to be same as for steel work welded in built-up sections as mentioned in para 9.4 except that steel used for fabrication of these items to be of type used for structural use/purposes.

9.17.2 Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

9.18 STEEL WORK WELDED IN BUILT UP SECTIONS FOR HAND RAIL USING OF M.S. TUBULAR/ERW TUBULAR PIPES AND G.I. PIPES
9.18.1 General specifications to be same as for steel work welded in built-up section as mentioned in para 9.4.

9.18.2.1 Hot finished welded (HFW) Hot finished seamless (HFS) and electric resistance welded tube shall conform to IS 1161.
9.18.2.2 G.I. pipes used for Hand rail to be conforming to IS 1239-Part I for medium grade. G.I pipes to be screwed and socketed type and of required nominal bore.
9.18.2.3 Galvanizing of G.I pipes shall conform to IS 4736.
9.18.2.4 All screwed tubes and socket of G.I pipes shall have pipe threads conforming to the requirements of IS 554.
9.18.2.5 The fittings for G.I pipes to be conforming to IS 1239 (Part-II).

9.18.2.6 Measurement of Hand Rail of M.S. Tubular/E.R.W Tubular Pipes
The work as fixed in place shall be measured in running meters correct to a centimeter and their weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified.
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10 : FLOORING
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List of Bureau of Indian Standard Codes
General:-
Definitions: - In order to sub-divide the potion between the plinth level or basement level and roof level, the solid constructions are carried out. These constructions are known as the floors and the exposed top surfaces of floors are termed as the floorings.

Factors affecting choice of flooring materials:- Following factors flooring of a particular buildings:

Material used for flooring:- Bricks, Cement Concrete, Terrazzo (Marble chip), Terrazzo Tile, Chequered Tile, Marble Stone, Kota Stone, Local Stone (Red White flag stone)

10.1 BRICK ON EDGE FLOORING
10.1.1 Bricks
The bricks shall be laid on edge of Specified dimension and designation shall be used. The broken bricks shall not be used in flooring. The specifications of bricks are described in Subhead Chapter of brick work.

10.1.2 Mortar
The mortar used shall be as given in the item.
In case of dry bricks flooring fine sand shall be filled in the joints.

10.1.3 Base Concrete:
10.1.3.1 The flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slope required for the flooring ranging from 1:36 to 1:48 depending upon locations, in floors of verandah, courtyard kitchens, and baths as decided by the Engineer-in-Charge. In case of water closet portion floor shall have slope of 1:30 or as per direction of Engineer in charge to drain out the water.

10.1.3.2 Before laying the flooring the base shall be wetted and smeared with a coat of cement slurry @ 2 kg of cement spread over an area of one sqm for a good bond between sub-grade and flooring. If the base is of lean cement concrete, the flooring shall commence within 48 hours of the laying of base, falling which, the surface of base shall be roughened with steel wire brushes without disturbing the concrete. Where base concrete is not provided, the earth below shall be properly sloped, watered, rammed and consolidated.

10.1.4 Soaking of Bricks
For flooring the bricks shall be perfectly soaked in stacks before use, in flooring by profusely spraying clean water at regular intervals for a period of minimum six hours so as to keep them wet to the satisfaction of the Engineer-in-Charge. The bricks need not be soaked where joints are to be filled with sand.

10.1.5 Laying
10.1.5.1 The bricks shall be laid on edge in plan, diagonal herring bone bond or other suitable pattern on 12 mm thick bed mortar of specified ratio. Each brick shall be properly bedded and set home by gentle tapping with trowel handle or wooden mallet. The inside face of the brick shall be buttered with mortar, before the next brick is laid and pressed against it.

10.1.5.2 On completion of a part of flooring, the vertical joints shall be fully filled from the top with mortar. During lying, the surface of the flooring shall be frequently checked with a straight edge of length at least 2 m, so as to obtain a true plain surface with the required slope.

10.1.6 Joints: - The jointing work in brick on edge flooring shall be done as given below.
1. The bricks shall be laid in a manner that all joints are full of mortar.
2. In any class of designation of brick the thickness of joints shall not exceed 1.0 cm.
3. All the face joints shall be raked to a minimum depth of 15 mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done.
4. In case where plastering or pointing is not required, the joints shall be struck flush and finished at the time of lying.
5. The face of brick work shall be cleaned on the same day on which brick work is done and all mortar droppings removed promptly.
10.1.7 Curing
The brick work in cement mortar shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

10.1.8 Measurements
In flooring Length and breadth shall be measured correct to a cm and area shall be calculated in square meters correct to two places of decimal. Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

When brick flooring laid in diagonal herring bone bond or other pattern as specified or as directed by the Engineer-in-Charge shall be measured separately.

10.1.9 Rate
The rate shall be including the cost of all materials and labour involved in all the operations described above, including application of cement slurry on base concrete or RCC slab and cleaning of base. Base concrete shall be paid for separately.

10.1.10 Dry Brick Flooring
All provisions of para’s 10.1.1 to 10.1.8 will be applicable except that bricks need not be soaked. Bricks will be laid on a bed of 12 mm thick mud mortar laid to required slope. The joints shall be as thin as possible and not exceeding 5 mm which will be filled with fine sand. Curing is not required.

10.1.10.1 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above.

10.2 CEMENT CONCRETE FLOORING:-
10.2.1 Cement Concrete
Cement concrete of specified mix grade shall be used and it shall generally conform to the specifications described under sub head 3.0.

10.2.2 Base Concrete

10.2.2.1 The flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slope required for the flooring ranging from 1:40 to 1:60 or as decided by the Engineer- in-charge, depending upon locations, of floors i.e. verandah, courtyard, kitchen, and baths etc. Further necessary drop in flooring in bath, WC, kitchen, near floor traps ranging from 6 mm to 10 mm will also be provided to avoid spread of water. To accommodate this drop necessary margin shall be made in the base concrete. Floor in water closet portion shall have slope of 1:30 or as per Engineer in charge to drain off water.

10.2.2.2 Before laying the flooring the base concrete shall be wetted and smeared with a coat of cement slurry @ 2 kg of cement spread over an area of one sqm for a good bond between sub-grade and flooring. The base shall be roughened with steel wire brushes without disturbing the concrete. The flooring shall be started preferably with in 48 hours of the laying of base concrete. Where C.C. flooring is to be done directly on RCC Slab, the surface of the slab shall be cleaned and a coat of cement slurry as above rate shall be spread over the area so as to get good bound between the slab and concrete floor.

10.2.3 Thickness
The thickness of floor shall be as specified.

10.2.4 Laying of concrete for flooring:-
10.2.4.1 Panels: The flooring of specified thickness shall be laid in the panels including border or as directed by the Engineer-in-Charge. The border panels shall not exceed 450 mm in width. The joints in the border shall be in line with panel joints. The panels shall be of uniform size. The area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitered for provision of strips.
10.2.4.2 Laying of Flooring with Strips: At the junction of two panels cement concrete flooring shall be laid in one operation using glass/PVC or any other strips as specified or as instructions of the Engineer-in-Charge. Normally 4 mm thick glass strips or 2 mm PVC strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun. In providing and fixing strips, cost of the strip shall be paid separately.

Concreting: Cement concrete shall be placed in the panels and be leveled with the help of straight edge and trowel and beaten with therpay or mason’s trowel. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the laborers. The tops of strips shall be visible clearly after finishing with cement slurry.

10.2.4.3 Laying of Flooring without Strips: laying of cement concrete flooring in alternate panels may be done if strips are not provided.

The panels shall be bounded by angle iron/flats. These shall have the same depth as the concrete flooring, and shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil before concreting. The flooring shall butt against the unflustered masonry wall.

The concreting shall be done in the manner described as para 10.2.4.2, the angle iron/flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends exposed, if damaged shall be repaired, with cement mortar 1:2 (1 cement: 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

10.2.5 Finishing
1. The finishing of the surface shall follow just after the beaten cessation. The surface shall be free from moisture before starting of finishing work. use of dry cement may be done to absorb excessive moisture.

2. Fresh cement shall be mixed with water to form a thick slurry and spreader @ 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

3. The junctions of floor with wall plaster, dado or skirting and the edges of sunk floors shall be finished and rounded off with cement mortar1:2(1 cement :2 coarse sand) and finished with a floating coat of neat cement.

4. The men engaged for finishing work shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

10.2.6 Curing
The curing shall be done for a minimum period of ten days and shall not be commenced until the top layer has hardened. Empty gunnies bag covering shall be avoided.

10.2.7 Precautions: - Fallowing precautions shall be taken in C.C. flooring work.-
1. The flooring in lavatories and bath room shall be laid only after fixing of water closet, squatting pans and floor traps.

2. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned.

3. During the execution of work any damage done to w.c, squatting pans and floor traps shall be made good.

4. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

10.2.8 Measurement
Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be the flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

10.2.9 Rate
1. The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on RCC slab or on base concrete including roughening and cleaning the surface but excluding the cost of strips which shall be paid separately under relevant item.

2. Nosings of steps where provided shall be paid for separately in running meter.

3. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunken floors.

4. In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

10.3 CEMENT CONCRETE FLOORING WITH METALLIC HARDENER TOPPING
10.3.1 The floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic harder is justified on the basis of cost. Then 12 mm thick metallic hardener topping shall be used.

10.3.2 Metallic Hardening Compound
The compound shall be of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. Where so directed by the Engineer-in-Charge and it shall be tested as below method:-

ABRASION TEST FOR CONCRETE HARDENING COMPOUNDS
1. Preparation of Sample
25 mm cylinder shall be prepared in ratio 1:2 mix (1 cement: 2 grades stone aggregate 6 mm nominal size by weight) one each with and without the admixture of concrete hardening compound. The concrete hardening compound shall be used in the proportion by weight of cement as recommended by the firm. The cylinder shall be placed inside a damp box for 24 hours and then cured in water for 27 days. After that, they shall be subject to abrasion test on ‘Dorry Type Avery Abrasion Testing Machine, using Emery powder No 80 as the abrasing medium under the condition given in Para 2 below;

2. Conditions of Test
(a) Area of rubbing surface shall be same in both the cylinders.
(b) Age of cylinder
(c) Duration of Test
(d) Total distance traverse during rubbing
(e) Pressure on rubbing surface

3. Results of Tests
The following observations shall be made in both the cases,
(a) Composition of the Test specimen
(b) Mean thickness rubbed away
(c) Percentage loss in weight

4. Remarks
Percentage loss in weight in the case of cylinders with concrete hardening compound should not be more than 40% of the percentage loss in the case of cylinder without concrete hardening compound.

10.3.3 Base Concrete
It shall be as specified in 10.2.2.

10.3.4 under Layer
Cement concrete flooring of specified thickness and mix as under layer shall be laid as per specification given in 10.2.1 & 10.2.4. The top surface shall be roughened with brushes while the concrete is still
green and the forms/strips shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping.

10.3.5 Topping
The topping shall be of 12 mm thick layer of mix 1:2 (1 cement: 2 stone aggregate 6 mm nominal size) by volume with which metallic hardening compound is mixed in the ratio of 1: 4 (1 metallic concrete hardener: 4 cement) by weight. Then enough water shall be added to this dry mix as required for floor concrete. The mixture so obtained shall be laid in 12 mm thick layer, on cement concrete floor within 2 to 4 hours its laying, & shall be laid true to provide a uniform and even surface. This layer shall be firmly pressed into the bottom concrete so as to have good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on, so as to prevent damage to new work.

The junction of floor with wall plaster, dado or skirting and finishing operations shall be as specified in para 10.2.5.

10.3.6 The specifications for curing, precautions to be taken, 'Measurements' and 'Rates' shall be as specified in para 10.2.6 to 10.2.9.

10.4 CEMENT PLASTER IN RISERS OF STEPS, SKIRTING & DADO
10.4.1 Skirting is a plaster at the bottom of wall not exceeding 30 cm in height above the floor. It shall be flush with wall plaster or projecting out uniformly by 6 mm from the wall plaster, or as specified. Its work shall be carried out simultaneously with the laying of floor and corner and junction also shall be finished as specified.

10.4.2 Thickness
The thickness of the plaster specified shall be measured exclusive of the thickness of key for grooves or open joints in brick work. The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges. The extra thickness required in rounding of corners at junctions of wall shall be ignored.

10.4.3 Preparation of Wall Surface:-
In masonry walls the joints shall be raked out 15 mm deep. In case of concrete walls, the surfaces shall be roughened by hacking & surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced. The skirting with specified mortar and thickness shall be laid immediately after the surface is prepared and shall be finished smooth with top truly horizontal and joints truly vertical except where otherwise indicated.

10.4.4 Finishing
The finishing of surface shall be done simultaneously with the borders or the adjacent panels of floor and cement to be applied in the form of slurry for smooth finishing shall be @ of 2 kg of cement per liter of water applied over an area of 1 sqm.

At the junction of skirting with plaster where skirting is flush with plaster, a groove 10 mm wide and upto 5 mm deep shall be provided in plaster.

10.4.5 Curing
Curing shall be commenced on the next day of plastering & shall be continued for minimum 7 days.

10.4.6 Measurement
Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimals for a specified the thickness. Length shall be measured as the finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm.

10.4.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations as described above.

10.5 CEMENT CONCRETE PAVEMENT IN COURTYARD AND TERRACE ETC.
10.5.1 Specifications described in para 10.2.1, 10.2.2.1, 10.2.3, 10.2.4, 10.2.6 and 10.2.7 shall hold good as far as applicable accept that:

(a) The panels shall be uniform in size and no dimension of a panel shall exceed 1.25 m and the Area of panel should not exceed 1.25 sqm for the thickness of panels upto 50 mm.

(b) Concreting shall be done in alternate panels only and no glass/asbestos strips shall be provided.

10.5.2 Finishing: - The finishing work shall be done as specified in point no. 1 of Para 10.2.5. in addition to that when the surface becomes fairly stiff, it shall be finished rough with wooden floats or where so specified chequered uniformly by pressing a piece of expanded metal of approved size.

10.5.3 Measurements
Same as 10.2.8 except that the volume will be calculated in cum nearest to two decimal places.

10.5.4 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above except the base concrete below flooring which shall be paid separately. Chequering to pattern shall be paid for separately unless otherwise specified.

10.6 TERRAZO (MARBLE CHIPS) FLOORING LAID IN SITU
10.6.1 Bottom layer (layer under top Layer)
Cement concrete of specified mix shall be used and the specifications as given in sub head 3.0 shall apply. The panels shall be of uniform size, not exceeding 2 sqm in area or 2 m in length for inside situations. In exposed situations, the length of any side of the panel shall not be more than 1.25 meter. Cement slurry @ 2.00 kg/sqm shall be applied before laying of under layer over the base cement concrete/RCC base.

10.6.2 Fixing of Strips
The fixing and laying shall be as specified in para 10.2.4.2. Strips of stone or marble or of any other material of specified thickness can also be used if specially required. Use of glass and metallic strips shall be avoided in areas exposed to sun.

10.6.3 Top Layer
10.6.3.1 Mortar: and laying of terrazzo:-The mix for terrazzo shall consist of cement with or without pigment, marble powder, marble aggregate (marble chips) and water. The cement and marble powder shall be mixed in the proportion of three parts of cement to one part marble powder by weight. For every part of cement marble powder mix, the proportion of aggregate by volume shall be as shown in Table below.

The marble chips shall be white or colored as specified. It shall be dense, sound, hard, homogenous texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. The maximum thickness of the top layer for various sizes of marble aggregates (marble chips) shall be as shown in Table 10.1 below:

<table>
<thead>
<tr>
<th>Grade No.</th>
<th>Size of Aggregates in (mm)</th>
<th>Proportion of Aggregates to Binder Mix</th>
<th>Minimum Thickness of Top Layer (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>1-2</td>
<td>1.75 : 1</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>2-4</td>
<td>1.75 : 1</td>
<td>6</td>
</tr>
<tr>
<td>1-</td>
<td>4-7</td>
<td>1.75 : 1</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>7-10</td>
<td>1.5 : 1</td>
<td>12</td>
</tr>
</tbody>
</table>

Where aggregate of size larger than 1 cm are used, the minimum thickness of topping shall not be less than 1 and 1/3 times the maximum size of the chips. Where large size chips such as 2 cm or 2.5 cm are used, they shall be used only with a flat shape and bedded on the flat face so as to keep the minimum thickness of wearing layer.

In advance before starting the work, the contractor shall get approved the sample of colors marble chips and mixing of colors chips by the Engineer in charge. The panel samples of minimum 1 m x 1 m
size shall be prepared and got approved from the Engineer-in-charge. The cement to be used shall be ordinary grey cement, white cement, cement with admixture of colouring matter of approved quality in the ratio specified or in the ratio to get the required shade as ordered by the Engineer-in-Charge. Colouring materials where specified shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full quantity of dry mixture of mortar required for a room shall be prepared in a lot in order to ensure a uniform colour. This mixture shall be stored in a dry place and well covered and protected from moisture. When required the dry mortar shall be mixed with water in the usual way. The mixed mortar shall be homogenous and stiff and contain just sufficient water to make it workable.

Laying of Terrazzo:-
The terrazzo topping shall be laid while the under layer is still plastic, but has hardened sufficiently to prevent cement from rising to the surface. This is normally achieved between 18 to 24 hours after the under layer has been laid. A cement slurry preferably of the same colour as the topping shall be brushed on the surface immediately before laying is started. It shall be laid to a uniform thickness slightly more than that specified in order to get the specified finished thickness after rubbing. The surface of the top layer shall be trowelled over, pressed and brought true to required level by a straight edge and steel floats in such a manner that the maximum amount of marble chips come up and are spread uniformly over the surface.

10.6.3.2 Curing, Polishing and Finishing:-
1. The surface shall be left dry for air-curing for duration of 12 to 18 hours depending on atmospheric temperature conditions and then be cured by allowing water to stand in pools over it for a period of minimum 4 days.

2. The grinding and polishing may be commenced after 2 days from the time of completion of laying for manual grinding and after 7 days for machine grinding. For polishing by machines, the surface shall be watered and ground evenly with machine fitted with special rapid cutting grit blocks (carborundum stone) of coarse grade (No. 60) till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface shall be thoroughly washed to remove all grinding mud and covered with a grout of cement and colouring matter in same mix and proportion as the topping in order to fill any pin holes that appear. The surface shall be allowed to dry for 24 hours and wet cured for 4 days and then rubbed with machine fitted with fine grit blocks (No. 120). Curing shall be done by ponding of water between panels formed with fine sand. The surface is cleaned and repaired as before and allowed to cure again for 3 to 5 days. Finally the third grinding shall be done with machine fitted with mere fine grade grit blocks (No. 320) to get even and smooth surface without pin holes. The finished surface should show the marble chips evenly exposed.

3. Where use of machine for polishing is not possible or feasible, rubbing and polishing shall be done by hand, in the same manner as specified for machine polishing except that carborundum stone of coarse grade (No. 60) shall be used for the 1st rubbing, stone of medium grade (No. 80) for second rubbing and stone of fine grade (No. 120) for final rubbing and polishing.

4. After the final polish either by machine or by hand, oxalic acid shall be dusted over the surface @ 33 gm/sqm sprinkled with water and rubbed hard with a nemdah block (Pad of Woolen rags). In common practice the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

10.6.4 Precautions
Same as specified in para 10.2.7

10.6.5 Measurements
10.6.5.1 Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. The area as laid shall be calculated in sqm correct to two decimal places. The under layer thickness shall be measured correct to a cm and top layer thickness shall not be less than that specified.

No deduction shall be made, nor extra paid for voids not exceeding 0.20 square meters. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square meters. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard.
10.6.5.2 In case of Terrazzo (Marble Chips) flooring laid as floor borders, margins and similar bands upto 0.3 m width and on stair case treads shall be measured under the item of terrazzo flooring but extra shall be paid for such work. And this extra in the case of staircase treads shall include the cost of forming the nosing also. However, moulded nosing shall be paid for staircase treads etc. extra in running meters except where otherwise stated; returned moulded ends and angles to moulding shall be included in the description. Extra shall also be paid for laying flooring in narrow bands not exceeding 7.5 cm in width and such bands shall be measured in running meters for this purpose. Special surface finishes to treads, risers and the ends of concrete steps and the like shall be measured separately and given in square meters and shall include form work, if required. Dividing strips inserted in terrazzo to form bays. Patterns shall be described stating the materials, its width and thickness and measured in running meters.

10.6.5.3 Rate:-
The rate shall include the cost of all materials and labour involved in all the operations described above including cleaning of surface of RCC slab or base concrete and application of cement slurry but shall not include the cost of base concrete and cost of providing and fixing strips of glass or aluminum or of any other material used for making panels, which shall be paid for separately.

10.7 TERRAZO (MARBLE CHIPS) SKIRTING IN SITU:-
10.7.1 Under Coat:-
The under coat of skirting shall be of cement plaster of the thickness and mix specified in the item. And for Specifications Para 10.4, 10.4.1 and 10.4.2 shall apply. The work shall be carried out in the manner described in para 10.4.3 except that the under coat shall be finished rough with a scratching tool to form a key for the top coat.

10.7.2 Top Coat:-
The specifications as in para 10.6.3 shall hold good as far as applicable and shall include cutting to line and fair finish to top edges of terrazzo and polishing.

10.7.3 Thickness:-
The thickness of the bottom and top coats shall be as specified. The total thickness of skirting specified is of the total thickness of plaster including top coat as measured from the un-plastered face of the masonry. Average thickness of the under coat shall be minimum 6 mm and minimum thickness over any portion of the surface shall not be less than 4 mm. The thickness of top coat shall not be less than the thickness as specified.

10.7.4 Measurements:-
Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal. Length shall be measured as finished length of skirting & height shall be measured from the finished level of floor correct to 5 mm where the height of skirting does not exceed 30 cm and when the height exceeds 30 cm it shall be measured correct to a cm.

10.7.5 Rates
The rate shall include the cost of all materials and labour involved in all the operations as described above.

10.8 WAX POLISHING
a. Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the floor/skirting,

b. When the layer of the wax is stiffened and surface of floor is saturated with the polish, polishing shall be resorted with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

10.8.3 The fresh polished floor surface shall be spreader with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed.

c. Measurements:-
Length and breadth shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal.
10.8.5 Rates:-
The rate shall include the cost of all materials and labour involved in all the operations described above.

10.9 CRAZY MARBLE FLOORING:- Crazy marble flooring shall be done as specified below.

1. Base Concrete:-
Crazy marble stone flooring shall be laid on cement concrete base and base concrete shall be provided with required slope for the flooring in verandahs and courtyards to drain off water. The surface of base shall be roughened with steel wire brushes, without disturbing the concrete, wetted and smeared with a floating coat of cement slurry at 2 kg/sqm so as to get a good bond between base and flooring. The same procedure shall also be adopted before laying the flooring on RCC slabs after removing laitance.

2. Under Layer:-
The under layer of crazy marble flooring shall be of cement concrete of thickness 25 mm in M-15 Grade concrete or 1:2:4 (1cement: 2 coarse sand: 4 stone grade aggregate of 12 mm size). It shall conform to the specifications given in the chapter of Cement Concrete.

10.9.3 Top Layer:-
The mix of crazy marble stone flooring shall consist of white cement with or without pigment, marble powder, marble chips of 00 Nos. and marble stone pieces and water. The marble stone pieces shall be hard, sound, dense and homogenous in texture with crystalline, coarse grains, uniform in colour and free from stains, cracks, decay and weathering. Before starting the work the contractor shall get the sample of marble stone approved by the Engineer-in-Charge. The thickness shall be according to the overall thickness specified which could be achieved when laid over the under layer as specified. Thus for 50 mm thick floor, the thickness of marble pieces will be 25 mm while for 40 mm thick floor, the thickness will be 15 mm.

The white cement and marble powder shall be mixed in proportion of three parts of cement and one part of marble powder by weight, and the proportion of marble chips to binder mix by volume shall be 7 parts of marble chips to 4 parts of binder mix.

10.9.4 Laying:-
A coat of cement slurry @ 2 kg/ sqm of area shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all the set marble stones shall be true to the required level and slopes. After fixing the stones, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces. The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

10.9.5 Polishing
Curing and Finishing shall be as described in para 10.6.3.2.

10.9.6 Precautions
Shall be as specified in para 10.2.7

10.9.7 Measurements
Length and breadth shall be measured correct to a cm before skirting, dado or wall plaster and it shall be calculated in sqm correct to two decimal places. No deduction shall be made nor extra paid for voids not exceeding 0.20 square meters. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square meters. Nothing extra shall be paid for laying floor at different levels in the same room or courtyards.

10.9.8 Rate
The rates shall include the cost of all materials and labour involved in all the operations described above including the cost of cleaning of RCC slab surface and applying the cement slurry, but it shall not include the cost of base concrete.

10.10 TERRAZO TILE FLOORING
10.10.1 Terrazzo Tiles
Terrazzo tiles flooring shall generally conform to IS 1237-Edition 2.3. Requirements and methods of testing of tiles are described as below:-
TEST REQUIREMENTS AND PROCEDURE FOR TESTING
"PRE-CAST CEMENT CONCRETE/ TERRAZO TILES"

1. Sampling
The tiles required of carrying out test shall be taken by 'random sampling'. Each tile sample shall be marked to identify the consignment from which it was selected.

Minimum quantity of tiles for carrying out the test and frequency of test shall be as specified in the list of Mandatory Test. The number of tiles selected for each mandatory test shall be as follows.

(a) For conformity to requirements on shape and dimensions, Wearing layer, and general quality - 12 tiles
(b) For wet transverse strength test - 6 tiles
(c) For resistance to wear test - 6 tiles
(d) For water absorption test - 6 tiles

Note: The tests on the tiles shall not be carried out earlier than 28 days from the date of manufacture.

2. Flatness of the Tiles Surface
The tiles when tested according to procedure laid down in IS: 1237 edition 2.3, the amount of concavity and convexity shall not exceed 1 mm.

3. Perpendicularity
When tested in accordance with the procedure laid down in IS 1237 edition 2.3, the longest gap between the arm of the square and edge of the tile shall not exceed 2 % of the length of edge.

4. Straightness
When tested as per IS 1237 edition 2.3, the gap between the thread and the plane of tile shall not exceed 1 % of the length of edge.

5. Water Absorption
When tested the average water absorption shall not exceed 10 %

6. Wet Transverse Strength Test
Six full size tiles shall be tested for the determination of wet transverse strength. When tested according to the procedure laid down in IS 1237 edition 2.3, the average wet transverse strength shall not be less than 3 N/mm² (30 kgf/cm²)

7. Resistances to Wear Test
When tested according to IS 1237 edition 2.3, average wear shall not exceed 3.5 mm and the wear on any individual specimen shall not exceed 4 mm, for general purpose tiles. And 2 mm and 2.5 mm of average wear on any individual specimen, respectively for heavy duty floor tiles.

<table>
<thead>
<tr>
<th>Material</th>
<th>Test</th>
<th>Field/ Laboratory Test</th>
<th>Test Procedure</th>
<th>Min. quantity of material for carrying out the test</th>
<th>Frequency of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrazzo Tiles</td>
<td>1. Transverse strength</td>
<td>Laboratory</td>
<td>IS:1237</td>
<td>5000 Nos. (no testing need be done if total number of tiles of all types of all sizes from all manufacturers used in a work is less than 5000 No’s)</td>
<td>One test for every 10,000 Nos. or part thereof for each type and size from a Single manufacturer. (One test to be done even if the number of terrazzo tiles of any type and size from a single manufacturers is less than 5000 Nos. provided the total number of</td>
</tr>
</tbody>
</table>
The size of tiles shall be as given in Table below or as specified or as required by the Engineer-in-Charge. Half tiles for use with the full tiles shall be such as to make two half tiles when joined together, match with the dimensions of one full tile.

### TABLE 1

<table>
<thead>
<tr>
<th>Pressed ceramic tiles (for floor &amp; wall)</th>
<th>1. Dimensions and surface quality</th>
<th>Laboratory</th>
<th>IS:13630</th>
<th>3000 Nos.</th>
<th>3000 Nos. or part thereof</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Physical properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Chemical properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10.10.1.1 **Tolerance:** Tolerances on length and breadth shall be ± one millimeter, and tolerance on thickness shall be ± 5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and 3 mm on thickness.

10.10.1.2 The tiles shall be manufactured in a factory under pressure process subjected to hydraulic pressure of not less than 140 kg/sq.cm and shall be given the initial grinding with machine and grouting of the wearing layer before delivery to site. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes and edges of wearing layer may be rounded.

10.10.1.3 The proportion of cement to aggregate in the backing of tiles shall be not leaner than 1:3 by weight. Where coloring material is used in the wearing layer, it shall not exceed 10% by weight of cement used in the mix.10.6.3.1 The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips ranging from the smallest upto 6 mm and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for size of marble chips varying from the smallest upto 20mm

### TABLE 10.2

<table>
<thead>
<tr>
<th>Length</th>
<th>Breadth</th>
<th>Thickness not less than</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Nominal</td>
<td></td>
</tr>
<tr>
<td>200mm</td>
<td>200 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>250mm</td>
<td>250 mm</td>
<td>22 mm</td>
</tr>
<tr>
<td>300 mm</td>
<td>300 mm</td>
<td>25 mm</td>
</tr>
</tbody>
</table>

10.10.2 Laying

10.10.2.1 Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar 1:4 (1Cement: 4coarse sand), thickness of mortar shall be 20 mm and shall not be less than 10 mm at any place.

10.10.2.2 Cement mortar bedding shall be spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are set. If cement mortar is laid in bedding the terrazzo tiles, these shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread @ of 4.4 kg of cement per square meter over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with cement grout of matching colour.

10.10.2.3 The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 meter, so as to obtain a true surface with the required slope.
Where full tiles or half tiles can not be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true Joint.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster and tile work shall be finished neatly and without waviness.

**10.10.3 Curing, Polishing and Finishing**

10.10.3.1 The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

10.10.3.2 The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60). Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120).

10.10.3.3 The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

10.10.3.4 For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used as below:-

1. 1st grinding — coarse grade stone (No. 60)
2. Second grinding — medium grade (No. 80)
3. Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

10.10.3.5 After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm/sqm sprinkled with water and rubbed hard with a ‘namdah’ block (pad of woolen rags). In common practice the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean. If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with a wooden mallet.

**10.10.4 Measurements**

10.10.4.1 Terrazzo tiles flooring with tiles manufactured from ordinary grey cement without pigment and coloured terrazzo tile flooring shall be measured separately according to para 10.6.5

10.10.4.2 Terrazzo tile flooring laid in floor borders and similar bands shall be measured under the item of terrazzo tile flooring. Nothing extra shall be paid in respect of these and similar bands formed of half size or multiply of half size standard tiles or other uncut tiles.

10.10.4.3 Treads of stairs and steps paved with tiles without nosing, shall also be measured under flooring. Moulded nosing shall be paid in running meter except where otherwise stated, returned moulded ends and angles to moulding shall be included in the description. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm.

**10.10.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. Where cement mortar bedding is used in place of lime mortar the rate will be adjusted accordingly.
10.11 TERRAZO TILES IN RISERS OF STEPS, SKIRTING AND DADO
10.11.1 The terrazzo tiles shall be as specified in 10.10.1, as far as applicable. The minimum finished thickness of tiles shall, however, be 12 mm. The finished thickness of the upper layer shall be not less than 5 mm for size of marble chips from the smallest upto 12 mm and not less than 6 mm for size of chips varying from the smallest upto 20 mm. Where the bigger sized chips are used the tiles shall be not less than 20 mm thick. The requirements of transverse strength tests specified in para 10.10.1, shall not apply when the tiles used are less than 20 mm thick.

10.11.2 Preparation of Surface
The specification for this shall be same as specified in para 10.4.2.

10.11.3 Laying
12 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) or mix as specified, shall then be applied and allowed to harden. The plaster shall then be roughened with wire brushes or by scratching diagonal lines 2 mm deep at approximately 7.5 cm centers both ways. The back of tiles shall be buttered with a coat of grey cement slurry and edges with grey or white cement slurry with or without pigments to match the shade of tiles, and set in the bedding mortar. These shall be tamped and corrected to proper planes and lines, the tiles shall be set in the required pattern and butt jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal with projection from finish wall surface not more than tile thickness and joints truly vertical except where otherwise indicated.

The risers of steps, skirting or dado shall rest on the top of the tread or flooring. Where full size tiles cannot be fixed, the tiles shall be cut to the required size and their edges rubbed smooth.

10.11.4 Curing, Polishing and Finishing
The specifications as in para 10.10.3. Polishing shall be done only with hand.

10.11.5 Measurements
The thickness of the skirting shall be as stated, Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread or floor to the top (the underside of tread in the case of steps). This shall be measured correct to 5 mm in case of risers and skirting (not exceeding 30 cm in height). In case of heights more than 30 cm, as in the case of dado and on walls, the height shall be measured correct to a cm and such work shall be paid for separately. The area shall be calculated in square meter, correct to two places of decimal.

Where the height of risers, skirting or dado does not admit of full size or other finished size tiles and the tiles are to be cut (sawn), nothing extra shall be paid for the same.

10.11.6 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be payable for use of cut (sawn) tiles to suit the size of risers, skirting, portions of dado etc.

10.12 CHEQUERED TILE FLOORING
10.12.1 Chequered Tiles
The sizes of tiles to be used shall be 20 x 20 cm, 25 x 25 cm and 30 x 30 cm or of standard sizes with equal sides or as shown in drawings or as required by the Engineer-in-Charge. The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm.

The overall thickness of the tiles shall not be less than 30 mm. The grooves in the chequers shall be uniform and straight and depth of the grooves shall not be less than 3 mm. The chequered tiles shall be cement tiles, or terrazzo tiles as specified in the description of the item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm.

10.12.2 Laying, curing, Polishing and Finishing shall be as specified in 10.10.2 and 10.10.3 except that the polishing of the tiles and the chequer grooves, after laying, may be done by hand. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion of the tiles. Cement concrete tiles normally do not require polishing but where polishing is required the same shall be done as described above.

10.12.3 Measurement and Rate: Shall be as specified in 10.11.5 and 10.11.6.
10.13 CHEQUERED TILES IN STAIR TREADS

10.13.1 Chequered Tiles
The specifications for tiles shall be as specified in 10.12.1 except in the following respects:
(1) The minimum thickness of the tile shall be 30 mm.
(2) The length of the tiles including nosing shall be as specified.
(3) The nosing shall also have the same wearing layer as the top.
(4) The nosing edge of the tile shall be rounded.
(5) The front portion of the tile for a minimum length of 75 mm from and including the nosing shall have grooves running parallel to the nosing and at centers not exceeding 25 mm. beyond that the tiles shall have the normal chequer pattern.

10.13.2 Preparation of Surface and Laying

10.13.2.1 RCC or brick work in treads on which the tiles are to be laid shall be cleaned wetted and mopped. The bedding for tiles shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or of specified mix. The minimum thickness of bedding mortar at any place shall be 10 mm. Bedding mortar shall be spread, tamped and corrected to proper levels. After laying bedding mortar, neat grey cement slurry of honey like consistency shall be spread over the mortar at the rate of 4.4 kg of cement/sq m over each tread. Tiles shall be washed cleaned and shall be fixed in this grout butting one at another. Each tile being gently tapped with a wooden mallet till it is properly bedded, and is in level and line with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines. The surface shall be checked with a straight edge during laying to obtain a true surface.

10.13.2.2 The square end of the tile shall, as far as possible butt against the riser face of the concrete or brick tread and in any case shall be embedded under the side wall plaster, skirting or dado and under the riser tile or other finish to a depth of not less than 10 mm.

10.13.2.3 Where full size tiles cannot be fixed, these shall be cut (sawn) to the required size (along the groove of the chequers where the cut edge is exposed) and used. The cut in the case of embedded edges will be neat and true while the cut in the case of exposed edges shall in addition be rubbed smooth to ensure straight and true joints. After the tiles have been laid surplus cement grout shall be cleaned off.

10.13.3 Curing, Polishing and Finishing
The specifications shall be as described in 10.10.3 except that polishing of the treads nosing and chequered grooves, after laying, may be done by hand in the same manner as specified under terrazzo tile flooring. Special care shall be taken to polish the nosing and the grooves in such a manner as to get a uniform, section for the grooves and the nosing and their finish shall match with the finish of the flat portion of the tiles.

10.13.4 Measurements
Chequred tiles on stair treads shall be measured in square meter correct to two places of decimal. Length shall be measured correct to a cm before laying skirting, dado or wall plaster. Width shall be measured correct to a cm from the outer edge of the nosing, as (aid, before providing the riser. In the case of the edge tiles of the landing and wide steps, width shall be measured up to the near edge of the chequered stair tread tiles. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square meters.

10.13.5 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above in para 10.11.6.

10.14 PRESSED CERAMIC TILE FLOORING

10.14.1 Pressed Ceramic Tiles
The tiles shall be of approved make flat, true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall conform to IS-15622, tested as per IS -13630 and classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.
The tiles shall be square or rectangular of nominal size. Table 1, 3, 5, and 7 of IS 15622 give the modular preferred sizes and table 2, 4, 6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for uncertified floor tiles and upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table 10 of IS 15622 with water absorption 3 to 6% (Group II).

The top surface of the tiles shall be glazed and shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base and edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 % of the surface area of the edges.

10.14.2 Coloured Tiles
Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

10.14.3 Decorative Tiles
The type and size of the decorative tiles shall be as follows:

(i) Decorated white back ground tiles the size of these tiles shall be as per IS 15622. (ii) Decorated and having coloured back-ground the sizes of the tiles shall be as per IS 15622.

10.14.4 Preparation of Surface and Laying
10.14.4.1 Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

10.14.4.2 Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it. Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread @ of 3.3 kg of cement/sqm over an area upto 1 sqm. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

10.14.4.3 The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

10.14.4.4 After tiles have been laid surplus cement slurry shall be cleaned off.

10.14.5 Pointing and Finishing
The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of Joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

10.14.6 Measurements
Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square meter correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.
No deduction shall be made nor extra paid for voids not exceeding 0.20 sq m. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sq m.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

10.14.7 Rate
The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. For tiles of sizes upto 0.16 sq m, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (sawn) tiles in the work. Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

10.15 ACID OR ALKALI RESISTANT TILES
10.15.1 Manufacture and Finish
The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength and acid resistance. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour.

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed 2%. The tiles shall be vitrified at the temperature of 1100°C and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to shape, flat and free from flows and manufacturing defects affecting their utility.

10.15.2 Dimensions and Tolerances
Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 X 98.5 mm, 148.5 X 148.5 mm and 198.5 X 198.5 mm with thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm and tolerance on length, breadth and thickness of tiles shall be ± 2%.

10.15.3 The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions, which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for squareness and warp as per IS 4457. The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

10.15.4 Marking
Tiles shall be legibly marked on the back with the name of the manufacturer’s or his trade mark batch number and year of manufacture. Each tile may also-be marked with the ISI certification mark.

10.15.5 Preparation of Surface and Laying
Preparation of surface and laying to be according to para 10.14.4, except the cement used to be acid and or alkali resistant cement and cement mortar to be used to be acid and or Alkali resistant mortar. Thickness of bedding of mortar for flooring to be 10 mm or specified on the item and for dado/skirting to be 12 mm or specified on item.

10.15.6 Pointing and Finishing
As per para 10.14.5, except that cement used for pointing to be acid and or alkali resistant cement.

10.15.7 Measurements
As per para 10.14.6.

10.15.8 Rate
The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. For tiles of sizes upto 0.16 Sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost cut tiles in the work.

11.16 PRESSED CERAMIC TILE FLOORING (VITRIFIED TILE FLOORING)
11.16.1 Operations as described in 11.14.1 to 11.14.6 shall be followed except the tiles shall conform to Table 12 of IS 15622 and the joint thickness in flooring shall not be more than 1 mm.
10.16.2 Rate
The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

10.17 FIXING OF TILE FLOORING WITH CEMENT BASED HIGH POLYMER MODIFIED QUICK SET ADHESIVE (WATER BASED)
10.17.1 When tile flooring is to be laid over the existing flooring without dismantling old flooring it can be laid with adhesive. The old flooring shall be thoroughly cleaned and checked for undulations, if any shall be rectified with cement mortar 1:3 (1 cement: 3 coarse sand) and cement concrete surface shall be hacked and cleaned off to have proper bond with the old surface.

10.17.2 High polymer modified quick set tile adhesive (conforming to IS 15477) shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used within 1.5 to 2 hours. The adhesive so spreader shall be combed using suitable trowel and over an area not more than one sqm at one time. Average thickness of adhesive shall be 3 mm the tiles shall be fixed and pressed firmly in position within 20 minutes of application of adhesive and surplus adhesive from the Joints, surface of the tiles shall be immediately cleaned. The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope. Where spacer lugs files are provided these shall be filled with grout with lugs remaining exposed. Where full size tile can not be fixed these shall be cut (sawn) to the required size and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall shall enter not less than 10 mm under plaster, skirting or dado.

10.17.3 Finishing; shall be as per para 10.14.5.

10.17.4 Measurements shall be as per para 10.14.6.

10.17.5 Rate
Provisions shall be as per para 10.14.7 and 10.16.2.

10.18 PRESSED CERAMIC TILES IN SKIRTING AND DADO
10.18.1 The tiles shall be conforming to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however, any glaze if unavoidable shall be permissible on only upto 50% of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one meter. The glaze shall be either glossy or matt, as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

10.18.2 Dimensions and Tolerances
Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm Joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above. The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cornices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

10.18.3 Preparation of Surfaces
The joints shall be raked out to a depth of at least 15 mm in masonry walls.
In case of concrete wall, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

10.18.4 Laying
12 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar in required partten and jointed. The tiles shall be tamped and corrected to proper plane and lines. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished "surface of wall" by more than the tile thickness; undulations if any shall be adjusted in wall.

10.18.5 Curing and Finishing
The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

10.18.6 Measurements
Length shall be measured correct to a cm, Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square meter, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes. Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

10.18.7 Rates
The rate shall include the cost of all material and labour involved in all the operations described above, for tiles of sizes upto 0.14 sqm. Unless otherwise specified in the description of the item. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

10.19 MARBLE STONE FLOORING
10.19.1 Marble Stone
It shall be as specified in sub head 7.0.

10.19.2 Dressing of Slabs
Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waviness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surfaces is in contact with every point on it. The sides and top surface of slabs shall be machined rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be 18, 30 or 40 mm as specified in the description of the item. Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of ± 2% shall be allowed.

10.19.3 Laying
10.19.3.1 Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and, mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as given in the description of the item.

10.19.3.2 The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab shall be not less than 12 mm.

10.19.3.3 The slabs shall be laid in the following manner:
Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying, it shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item. The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm. Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of Veins/streaks or as directed by the Engineer-in-Charge.

10.19.3.4 The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

10.19.3.5 Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

10.19.3.6 Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

10.19.4 Polishing and Finishing
Slight unevenness at the meeting edges of slabs shall then be removed by fine chiseling and finished in the same manner as specified in 10.10.3 except that cement slurry with or without pigments shall not be applied on the surface before each polishing.

10.19.5 Measurements
Marble stone flooring with different kind of marble shall be measured separately and in square meter correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 square meters. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square meters. Nothing extra shall be paid for laying the floor at different levels in the same room. Steps and treads of stairs paved with marble stone slabs shall also be measured under the item of Marble Stone flooring. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm. nosing for treads shall be measured in running meter and paid for extra. The width of treads shall be measured from the outer edge of the nosing, as laid, before providing the riser.

10.19.6 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above. However, extra shall be paid for making special type of pattern/design/flowers as per drawings. No deductions shall be made in rate even if flooring is done without any pattern/design.

10.20 MARBLE STONE IN RISERS OF STEPS AND SKIRTING
10.20.1 Marble Stone Slabs and Dressing of Slabs shall be as specified in 10.19.1 and 10.19.2 except that the thickness of slabs shall be 18 mm. A tolerance of ± 3% mm shall be allowed, unless otherwise specified in the description of the item.

10.20.2 Preparation of Surface
It shall be as specified in 10.15.5 where necessary; the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

10.20.3 Laying
The risers of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12 mm and at no place the width shall be less than 10 mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed into the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement: 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

10.20.4 Curing, Polishing and Finishing
It shall be as specified in 10.11.4 as far as applicable, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

11.20.5 Measurements
Length shall be measured along the finished face of riser or skirting; correct to a cm. Height shall be measured from the finished level of tread or floor, to the top (the underside of tread, in the case of steps) correct to 0.5 cm. The areas shall be calculated in square meter correct to two places of decimal. Dado and lining of pillars etc. shall be measured as 'Marble work in wall lining. If the thickness is upto 25 mm or as "Marble Work" in Jambs, walls, columns and other plain work’ if the thickness is more.

10.20.6 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

10.21 KOTA STONE FLOORING
10.21.1 Kota Stone Slabs
The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws, and hand or machine cut to the requisite thickness. The slab shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site of required size, unless otherwise specified. The contractor shall get the samples of slabs approved by the Engineer-in-Charge, before starting the work.

10.21.2 Dressing
Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the description of the item. Tolerance of ±2 mm shall be allowed for the thickness. In length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut stabs shall be allowed.

10.21.3 Preparation of Surface and Laying
The specification shall be as described in 10.15.5 except that the edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab and thickness of the joint should be minimum to 1 mm.
10.21.4 Polishing and Finishing
The specifications shall be as described in 10.19.4 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

10.21.5 Measurements and Rates
These shall be as described in para 10.19.5 and 10.19.6.

10.22 KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO
10.22.1 Kota Stone Slabs and Dressing shall be as specified in 10.21.1 and 10.21.2 except that the thickness of the slabs shall be 25 mm and in uniform size or as specified in the description of the item.

10.22.2 Preparation of surface shall be as specified in 10.20.2.

10.22.3 Laying shall be as specified in 10.20.3 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

10.22.4 Curing, Polishing and Finishing shall be as specified in 10.20.4 except that first polishing with coarse grade carborundum, stone shall not be done.

10.22.5 Measurements
Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread of floor to the top (the underside of tread in the case of steps). This shall be measured correct to a mm in the case of risers of steps and skirting and correct to a cm in the case of dado. The area shall be calculated in square meter correct to two places of decimal. Lining of pillars etc. shall also be measured under this item.

10.22.6 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

10.23 RED OR WHITE FINE DRESSED SAND STONE FLOORING
10.23.1 Stone Slabs shall be red or white as specified in the description of the item. The stone slabs shall be hard, sound, durable and tough, free from cracks, decay and weathering. In case of red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted. The contractor shall get samples of slabs approved by the Engineer-in-Charge before starting the work. The slabs shall be hand or machine cut to the requisite thickness along planes parallel to the natural bed of stone and should be of uniform size if required.

10.23.2 Dressing of Slabs
Every slab shall be cut to the required size and shape and chisel dressed on all sides to a minimum depth of 20 mm. The top and the Joints shall be fine tooled so that straight edge laid along the face is fully in contact with it. In case machine cut stones are used, chisel dressing and fine tooling of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surface is in contact with every point on it. The thickness of the slabs after dressing shall be 40 mm or as specified in the description of item with a permissible tolerance of ± 2 mm.

10.23.3 Laying
10.23.3.1 Base concrete on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:5 (1 cement: 5 coarse sand) or as given in the description of the item.

10.23.3.2 The average thickness of the bedding mortar under the slabs shall be 20 mm and the thickness at any place under the slabs shall not be less than 12 mm.

10.23.3.3 The slab shall be laid in the following manner: The slab shall be washed clean before laying and mortar of specified mix shall be spreader under each slab. Slab then be laid on top, pressed and larried; so that all hollows underneath get filled and surplus mortar works up through the joints. The top shall be tapped with a wooden mallet and brought to level and close to the adjoining slabs; with thickness of joint not exceeding 5 mm. Subsequent slabs
shall be laid in the same manner. After laying each slab surplus mortar on the surface of slabs shall be cleaned off and joints finished flush.

10.23.3.4 In case pointing with other mortar mix is specified, the joint shall be left raked out uniformly and to a depth of not less than 12 mm when the mortar is still green. The pointing shall be cured for a minimum period of 7 days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge.

10.23.3.5 Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the Plaster, skirting or dado. The junction between wall plaster skirting and floor shall be finished neatly and without waviness. The finished floor shall not sound hollow when tapped with wooden mallet.

10.23.4 Finishing
In case of chisel dressed stone flooring slight unevenness, if any existing between the edges of slabs at joints shall then be removed by chiseling in a slant.

10.23.5 Measurements
These shall be as specified in para 10.19.5.

10.23.6 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above. Where pointing is to be done, this will be paid extra unless specifically included in the description of the item.

10.24 RED OR WHITE FINE DRESSED AND RUBBED SAND STONE FLOORING
10.24.1 Stone Slabs shall be as specified in 10.23.1.

10.24.2 Dressing
The specifications for dressing the top surface and the sides shall be as described in 10.23.2. In addition the dressed top and sides shall be table rubbed with coarse grade carborundum stone before paving, to obtain a perfectly true and smooth surface free from chisel marks. The thickness of the slabs after dressing shall be as specified with a permissible tolerance of ± 2 mm.

10.24.3 Laying
The slabs shall be laid with 3 mm thick or 5 mm thick joints as specified in the description of the item. Where the joints are to be limited to 3 mm thickness, the slabs shall be laid as specified in 10.19.3 except that the bedding mortar shall be as specified in 10.23.3 and sides of the slabs to be jointed shall be buttered with cement mortar 1:2 (1-cement; 2 stone dust) admixed with pigment to match the shade of the slab. Where the slabs are to be laid with 5 mm thick joints, the specifications for laying shall be as described in 10.23.3.

10.24.4 Finishing shall be as specified in 10.23.4 except that chisel marks and unevenness shall be removed by rubbing with coarse grade carborundum stone.

10.24.5 Measurement and rates shall be as specified in para 10.23.5 and10.23.6
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<th>IS No.</th>
<th>Subject</th>
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<tbody>
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<td>Specification for 33 grade ordinary portland cement</td>
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<td>2.</td>
<td>IS 401</td>
<td>Code of practice for preservation of timber</td>
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<td>3.</td>
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<td>12.</td>
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<td>Specification for bitumen felts for water proofing and damp-proofing</td>
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<td>Code of practice for laying and finishing of cement concrete flooring tiles</td>
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<td>14.</td>
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<td>Acid and/or alkali Resistant tiles.</td>
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<td>22.</td>
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<td>Code of practice for laying of hard wood parquet and wood block floors</td>
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<td>23.</td>
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<td>29.</td>
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11.0 : ROOFING and CEILING
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Definition :-

**Eaves**
It is the lower edge of the inclined roof.

**Finial**
It is a decorative fitting used at the junction of ridges and hips to form a waterproof covering and at the top of conical, pyramidal, or dome roofs.

**Flash**
It is a strip of impervious material, usually metal used to exclude water from the junction between a roof covering and another part of the structure.

**Gable**
It is a part of wall above the general eaves level at tie end of ridged or partially hipped roof.

**Gutter**
Any form of roof water channel is known as Gutter.

**Hip**
The outer angle (more than 180°) formed by the inclined ridge between two intersecting roof slopes is known as Hip.

**Pitch**
Is the angle of inclination with the horizontal of the rafters or substructure surface on which the roof coverings are laid.
In patent glazing, the angle at which the plane of a stretch of glazing is inclined to the horizontal.

**Pitched Roof**
Is a roof the pitch of which is greater than 10 degree to the horizontal?

**Ridge**
Is the horizontal inter-section at the apex of the two rising roof surfaces inclined in opposite directions?

**Valley**
The re-entrant angle formed by the inter-section of two inclined roof surfaces is known as Valley.

**Verge**
Is the free edge of a roof surface ending at a gable?

**Accessories**
Purpose made fittings, such as apron flashing pieces, barge boards, bottom glazing flashing, corner piece (corner flashing), eaves filler pieces, expansion joints, hip capping, hip tile or cap, ridge capping, ridge finials, roof lights, ventilators, with which the roof is furnished.

11.1 CORRUGATED GALVANISED STEEL SHEET ROOFING

11.1.1 C.G.S. Sheets
Theses shall conform to IS 277 and the thickness shall be as specified in the description of the item. The sheets shall be of 275 grade of coating (as described below) unless otherwise specified in the description of item.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanizing shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

GALVANISED STEEL SHEETS
_Clause 11.1.1_

11.1.1.1 Dimension of GI sheets:- As per IS 277 the dimension of GI sheets shall be as given below
1.0 Sizes of plain Sheet:
(a) Length: 1800, 2200, 2500, 2800 and 3000 mm
(b) Width: 750, 900, 1000 and 1200 mm
(c) Thickness of uncoated sheet: 0.18, 0.22, 0.25, 0.28, 0.32, 0.40, 0.45, 0.50, 0.55, 0.63, 0.70, 0.80, 0.90, 1.0, 1.25, 1.6 mm

1.1 In case of sheets supplied in coil, the internal diameter of coil shall be 450, 510 and 610 mm and the mass of each coil shall not exceed 12 tonne.

a) Coils weighing more than 12 tonne may be supplied subject to mutual agreement between the contracting parties.

1.2 Corrugated sheets.
a) The length of the corrugated sheets shall be as follows: 800, 2200, 2500, 2800, 3000, 3050 mm

11.1.1.2 Zinc Coating for Galvanizing
The weight of coating referred to in this specification shall represent the total weight of zinc both sides inclusive. On any sample selected at random from the delivery, one set of three samples each 50 x 50 mm or 50 mm diameter shall be selected at random from one sheet for every 500 G.S. sheets, the coating for the different classes shall be within the limit specified in Table A given below; when tested as per method giving in 6745.

<table>
<thead>
<tr>
<th>Grade of coating</th>
<th>Minimum average coating Triple spot test g/sqm</th>
<th>Minimum coating single spot test g/sqm*</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>600</td>
<td>510</td>
</tr>
<tr>
<td>450</td>
<td>450</td>
<td>380</td>
</tr>
<tr>
<td>350</td>
<td>350</td>
<td>300</td>
</tr>
<tr>
<td>275</td>
<td>275</td>
<td>235</td>
</tr>
</tbody>
</table>

* Minimum individual value obtained in triple spot test.

11.1.1.3 Mass of GI sheets
The mass of sheets and coils shall be calculated as given in Table B on the basis of nominal dimensions and mass of zinc coating.

<table>
<thead>
<tr>
<th>Type of materials</th>
<th>Order of calculation</th>
<th>Method of calculation</th>
<th>Number of Numerals in resultant value</th>
</tr>
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<tbody>
<tr>
<td>Sheet</td>
<td>Mass of single sheet</td>
<td>Nominal mass of single sheet plus mass of zinc coating</td>
<td>Rounded off to 4 effective figures for mass of coating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mass of single sheet (kg) x number of sheets</td>
<td>Rounded off to integral value of kg</td>
</tr>
<tr>
<td></td>
<td>Total mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unit mass of coil</td>
<td>Unit mass of sheet (kg/m²) x width (mm) x 10⁻³</td>
<td>Rounded off to 3 effective figures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mass of single coil</td>
<td>Unit mass of coil (kg/m) x length (m)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total mass (kg)</td>
<td>Total mass of each coil</td>
<td>Integral number of kg</td>
</tr>
</tbody>
</table>

Note:

a) Nominal mass of single sheet shall be calculated by calculating the volume of the sheet and multiplying the same with density of sheet (density 7.85 g/ cubic cm) and rounding the same to 4 effective figures.

b) Mass of the coating shall be calculated by multiplying the surface area of single sheet with indicated/nominal coating mass (g/square meter) as shown for triple spot test (Table A).

c) For calculation of corrugated sheet mass, the width before corrugation shall be considered while calculating the area.
11.1.1.4 Corrugations
The depth and pitch of corrugation shall be as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Depth of Corrugation (mm)</th>
<th>Pitch of Corrugation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>17.5</td>
<td>75</td>
</tr>
<tr>
<td>B</td>
<td>12.5</td>
<td>75</td>
</tr>
</tbody>
</table>

The number of corrugations shall be 8, 10, 11 or 13 per sheet. The overall width of the sheets before and after corrugation shall be as given in Table below.

**TABLE C**
Details of Corrugations

<table>
<thead>
<tr>
<th>Number of corrugations</th>
<th>Grade</th>
<th>Nominal overall width of sheet measured between crowns of outside corrugations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before corrugation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mm</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>750</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
<td>900</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>1000</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
<td>1200</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>750</td>
</tr>
<tr>
<td>10</td>
<td>B</td>
<td>900</td>
</tr>
<tr>
<td>11</td>
<td>B</td>
<td>1000</td>
</tr>
<tr>
<td>13</td>
<td>B</td>
<td>1200</td>
</tr>
</tbody>
</table>

11.1.1.5 Tolerance as per IS 277:-
Length - No sheet shall be smaller in length than that specified. Tolerance on plus side shall be 15mm or 0.5 percent of length, whichever is greater.

The diagonal distance between opposite corners of any sheet shall not differ by more than 20 mm.

Width - No plain sheet shall be smaller in width than that specified. The positive tolerances on width shall be 10 mm.

Thickness - The tolerance on thickness of sheet and coil shall be according to IS 1079:1988 or IS 513:1986 as applicable.

Tolerance on Mass
The tolerance on mass of individual sheets calculated in accordance with 12.2 shall be within ± 10 percent and tolerance on mass of each bundle of sheet shall be ± 5 percent.

11.1.2 Purlins
Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters. These shall not be spaced at more than the following distances. (Table D)

**TABLE D**

<table>
<thead>
<tr>
<th>Thickness of C.G.S. sheet</th>
<th>Maximum spacing of purlins</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00 mm</td>
<td>2.00 meter</td>
</tr>
<tr>
<td>0.80 mm</td>
<td>1.80 meter</td>
</tr>
<tr>
<td>0.63 mm</td>
<td>1.60 meter</td>
</tr>
</tbody>
</table>

The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.
11.1.3 Slope
Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

11.1.4 Laying and Fixing of GI sheet:
(a) The GI sheets shall be laid and fixed in the manner described below, unless otherwise shown in the approved drawings or directed by the Engineer-in-Charge.

(b) The GI sheets shall be laid on the purlins or other structural member to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

(c) Laying of GI sheets shall commence from the lower end (bottom) of roof. The GI sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

(d) Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

(e) Sheets shall not generally be fixed into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.

(f) The laying operation shall include all scaffolding work involved.

(g) Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with galvanized J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washer filled with white lead as directed by the Engineer-in-Charge. White J hooks are used for fixing sheets on angle iron purlins, and L hooks are used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements. The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlins shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach Screws shall not be used for fixing sheets to purlins.

(h) The galvanized coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability. The galvanized coating should conform to IS 1367 (Pt. XIII)

(i) Where slopes of roofs are less than 21.5 ° (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron bolts and nuts 25 x 6 mm size, each bolt provided with bitumen and a G.I. limpet washer or a G.I- limpet washer filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

11.1.5 Wind Tie
Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. The ties shall be paid for separately unless described in the item of roofing.
11.1.6 Finish
The roof when completed shall be true to lines, slopes and shall be leak proof.

11.1.7 Measurements
(a) The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

(b) The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc; shall be included in the measurements of the roof.

(c) Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girted.

(d) There shall be no deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girted. No additions shall be made for laps cut through.

11.1.8 Rate
The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.S. sheets. This includes the cost of roof sheets, galvanized iron J or L hooks, bolts and nuts, galvanized iron seam bolts and nuts, bituminous and galvanized iron limpet washers etc.

11.2 RIDGES AND HIPS OF PLAIN GALVANISED STEEL SHEETS
11.2.1 Ridges and Hips
Ridges and hips of corrugated Galvanized steel sheet roof shall be covered with ridge and hip sections of plain G.S. sheet with a minimum lap of 20 cm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.S. sheet 0.6 mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.

11.2.2 Fixing
(a) Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

(b) The, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If it is not possible extra hook bolts shall be provided.

(c) The end laps of ridges and hips shall be joined together with C.G.S sheet by galvanized iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

(d) Surface of C.G.I, sheets of ridge and hip sections and the roofing sheets which overlap each other shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. Sheets before they are fixed in place.

11.2.3 Finish
The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

11.2.4 Measurement
The measurements shall be taken for the finished work in length along the centre line of ridge or hip, as the case may be, correct to a cm. The laps in ridges and hips and between ridges and hips shall not be measured.
11.2.5 Rate
The rate shall include the cost of all labour and materials specified above, including painting, cost of
seam bolts and any extra G.I. hook bolts, nuts and washers, required.

11.3 VALLEY AND FLASHING OF PLAIN GALVANISED STEEL SHEETS
11.3.1 Valley and Flashing
Valley shall be 90 cm wide overall plain G.S. sheet 1.6 mm thick or other size as specified in the item
bent to shape and fixed. They shall lap with the G.G.S. sheets not less than 25 cm width on other side.
The end laps of valley shall also be not less than 25 cm. Valley sheets shall be laid over 25 mm thick
wooden boarding if so required. Flashing shall be of plain G.S. sheet of 40 cm overall width 1.25 mm
thick or 1.00 mm thick as specified in the item bend to shape and fixed. They shall lap not less than 15
cm over the roofing sheets. The end laps between flashing pieces shall not be less than 25 cm.

11.3.2 Laying and Fixing
(a) Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley
rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix
the sheets to those roof members.

(b) At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If
this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5
cm inside masonry with the mortar of mix 1: 3 (1 cement: 3 coarse sand).

(c) Surface of G.S. sheets under overlaps shall be painted with a coat of approved primer and two coats
of approved paint suitable for painting G.S. sheets.

(d) The edges of valley and flashing should be straight from end to end. The surfaces should be true
and without bulges and depressions.

11.3.5 Measurements
The length of the valleys and flashing shall be measured for the finished work correct to a cm. The taps
along the length of the valley or flashing pieces, including the portion embedded in masonry shall not be
measured.

11.3.6 Rates
The rate for valleys, shall be for all the labour and materials specified above, including painting, cost of
seam bolts and the cost of requisite G.L hook bolts, nuts and washers required over and above those
needed for connecting the roof sheets to the roof members. The rate for valleys shall exclude the cost
of boarding underneath which shall be paid for separately. The rate for flashing shall be for all the
labour and materials specified above, and shall include the cost of painting and mortar for fixing in wall.

11.4 GUTTERS MADE OF PLAIN GALVANISED STEEL SHEETS
11.4.1 Gutters
Gutter shall be fabricated from plain G.S. Sheets of thickness as Specified in the item. Eaves gutters
shall be of the shape and section specified in the description of the item. The overall width of the sheet
referred to therein shall mean the peripheral width of the gutter including the rounded edges. The
longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge. The
ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid
leakage. Gutter shall be laid with a minimum slope of 1 in 120.

11.4.2 Laying and Fixing of Gutters
(a) Gutter shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the
requisite slope. The maximum spacing of brackets shall be 1.20 meters.

(b) If these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bend to
shape and fixed rigidly to the sides of rafters with 3 No’s 10 mm dia bolts, nuts and washers. The
brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centers.

(c) If the brackets are to be fixed to the purlins, the brackets shall consist of 50 x 3 mm M.S. flat iron
bent to shape with one end turned at right angle and fixed to the purlin face with 2 Nos. of 10 mm dia
bolts nuts and washers. The bracket will be stiffened by provision of 50 x 3 mm M.S. flat whose over
hung portion bent to right angle shape with its longer leg connected to the bracket with 2 No’s of 6 mm
dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 No. 10 mm dia, bolt, nut and washer. The over hang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 meters.

(d) The gutter shall be fixed to the brackets with 2 Nos. of G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

(e) For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and reverted to the gutter, the other end tailing into the socket of the rain-water pipe. Wherever necessary stop ends, angles etc. should be provided.

11.4.3 Finish
The gutters when fixed shall be true to line and slope and shall be leak proof.

11.4.4 Measurements
Measurements shall be taken for the finished work along the centre line of the top width of the gutter connection to a cm. The hooked lap portion in the junctions and gutter lengths shall not be measured. The number of brackets which are fixed to purlins with stiffener flats should be measured.

11.4.5 Rate
The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends or funnel shaped connecting pieces, stop ends etc., flat iron brackets and bolts and nuts required for fixing the latter to the roof members. Brackets of 50 x 3 mm flats fixed to purlins with stiffener flats will be paid extra.

11.5 NON-ASBESTOS HIGH IMPACT POLY PROPYLENE REINFORCED CEMENT CORRUGATED SHEET ROOFING
11.5.1 Non-Asbestos High Impact Poly Propylene Reinforcement Cement Corrugated Sheets shall be free from cracks, chipped edges or corners and other damages. The sheets shall be of the approved quality and shall conform to IS 14871

11.5.2 Classification of sheets
Sheets may be classified according to thickness as under:
Type A - The thickness of the sheets shall be approximately constant throughout the width of profile.

Type B - The thickness of the sheets shall vary regularly between the valley and the crown for corrugated sheets or between the lower part and the upper part of ribs for a symmetrical section sheets, in the same cross-section.

11.5.3 Slope
The roof shall not be pitched at flatter slope than 1 in 5. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

11.5.4 Laying
(a) The sheets shall be laid on the purlins and other roof members as indicated in the working drawings or as instructed by the Engineer-in-Charge.

(b) The maximum spacing of purlins under the sheets shall be 1.40 meters in the case of 5.5 mm thick sheets and these shall in no case be exceeded. Ridge purlins shall be fixed at 75 mm to 115 mm from the apex of the roof.

(c) The top bearing surfaces of all purlins and of other roof members shall be in one plane so that the sheets when being fixed shall not require to be forced down to rest on the purlins. The finished roof shall present a uniform slope and the line of corrugations shall be straight and true. The sheets shall be laid with the smooth side upwards

(d) The sheets shall be laid with a side lap of half a corrugation and an end lap of 15 cm minimum in the case of roofs with a pitch flatter than 1 vertical to 2.5 horizontal (approx. 22°) or in the case of very exposed situations, the minimum permissible end lap shall be 20 cms. Side laps should be laid on the side facing away from the prevailing monsoon winds.
(e) The free overhang of the sheets at the eaves shall not exceed 30 cm. Corrugated sheets shall be laid from left to right starting at the eaves. The first sheet shall be laid uncut but the remaining sheets in the bottom row shall have the top left hand corners cut or mitred. The sheets in the second and other intermediate rows except the first and the last sheets, shall have both the top left hand corner and bottom right hand corner cut. The last or top row sheets shall all have the bottom right hand corner cut with the exception of the last sheet which shall be laid uncut. If for any reason such as on considerations of the direction of prevailing winds, laying is to be started from the bottom right hand corner, then the whole procedure should be reversed.

(f) The 'Mitred' described above is necessary to provide a snug fit where four sheets meet at a lap. It is cut from a point 15 cm (or whatever the length of the end lap may be) up the vertical side of the sheet to a point 5 cm along the horizontal edge. This cutting may be done with an ordinary wood saw at site.

11.5.4 Fixing
(a) Sheets shall be secured to the purlins and other roof members by means of 8 mm diameter polymer coated iron J or L hook bolts and nuts. While, J hooks are used for fixing to angle iron purlins. L hooks are used for fixing to R.S. Joists, timber or precast concrete purlins.

The grip of the J or L hook bolt on the side of the purlin shall not be less than 25 mm. Each iron J or L hook bolt shall have a bitumen washer and a galvanized iron washer placed over the sheet before the nut is screwed down from above. On each purlin there shall be one hook bolt on the crown adjacent to the side lap on either side. Bitumen washer shall be of approved manufacture. Galvanizing of washers shall be as provided in para 11.1.4.h. Polymer coating of hooks, bolts and nuts shall be as per IS code 14871.

(b) The G.I. flat washer shall be 25 mm in diameter, 1.6 mm thick and the bitumen washer shall be 35 mm in diameter and 1.5 mm thick. The length of J bolt or crank bolt shall be as specified in Table below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Situation</th>
<th>Length of Bolts</th>
<th>No. of Bolts &amp; Washers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>At horizontal (end) laps of Sheets. At eaves when filler pieces are used. At ridge when sheets and ridge pieces are secured by the same bolt.</td>
<td>Depth of purlin plus 90 mm.</td>
<td>Twice the No. of sheets in one horizontal course.</td>
</tr>
<tr>
<td>2.</td>
<td>At eaves when filler pieces are not used. At ridge when corrugated sheets and ridge pieces are not secured by the same bolt.</td>
<td>Depth of purlin plus 75 mm.</td>
<td>Twice the No. of sheets in the horizontal course.</td>
</tr>
<tr>
<td>3.</td>
<td>At intermediate purlins where horizontal laps do not occur.</td>
<td>Depth of purlin plus 75 mm.</td>
<td>Twice the No. of sheets in the horizontal course.</td>
</tr>
</tbody>
</table>

(c) At first each nut shall be screwed lightly. After a dozen or more sheets are laid, the nuts shall be tightened to ensure a leak proof joint.

(d) Holes for hook bolts etc. shall be drilled and not punched, always through the crown of the corrugation and not in valleys, in locations to suit the purlins while the sheets are on the roof in their correct position. The diameter of holes shall be 2 mm more than the diameter of the fixing bolts, No hole shall be nearer than 40 mm to any edge of a sheet or any accessory.

(e) Roof ladders or planks shall always be used when laying and fixing the sheets, to avoid damage to the sheets, and to provide security to the workmen.

11.5.5 Wind Ties
Wind ties may be provided where the situation justify their provision. These shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eave ends of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be paid for separately unless described as included in the items of the roof work.
11.5.6 Finish
The completed roof shall present a neat and uniform appearance and be leak proof.

11.5.7 Measurements
These are specified in para 11.1.7 shall be applicable accept the breadth of the roof shall be measured along the rest of the curved sheets.

11.5.8 Rate
The rate shall include the cost of all the materials and labour involved in all the operations described above except otherwise stated. This includes the cost of roof sheets, polymer coated or L hook, bolts and nuts, bituminous and galvanized iron washers.

11.6 NON-ASBESTOS HIGH IMPACT POLY PROPYLENE REINFORCED CEMENT SEMI-CORRU-GATED SHEET ROOFING
11.6.1 Non Asbestos High Impact Poly Propylene Reinforced Cement Semi Corrugated Sheets
These shall be of the specified thickness and of approved quality and shall conform to IS 14871 they shall be free from cracks, chipped edge corners or other damages.

11.6.2 Laying
The specifications for laying shall be the same as described in 11.5.3 except that
(i) the sheets shall be laid with the end stamped ‘Top’ on the smooth side pointing towards the ridge,
(ii) the sheets shall invariably be laid from right to left starting at the eaves with the procedure for mitring etc. described under 11.5.3.(e) and 11.5.3.(f) reversed,
(iii) the side laps provided will be of one corrugation, the left hand small corrugation of each sheet being covered by the right hand large corrugation of the next sheet and
(iv) asbestos cement expansion joints shall be inserted every 45 meters or so in the length of the roof. Specially manufactured expansion joint pieces shall be used for the purpose. The end lap of expansion joints shall not be less than 150 mm. If the expansion Joints may be between the purlins, these should be stitched with seam bolts.

11.6.3 Fixing
The specifications shall be same as described in 11.5.4 except that along each line of purlin there shall be a hook bolt in every vertical side lap corrugation and at the two verges and there shall be an additional hook bolt through one of the two intermediate corrugations on each sheet. When sheets are supported over intermediate purlins as in the case of length over 1.40 meters for 5.5 mm thick sheets, fixing accessories are required on the intermediate purlins, through each side lap and the verges only.

The number and length of bolts and number of bituminous felt and galvanized iron washers are given in Table F

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Situation</th>
<th>Length of Bolts</th>
<th>No. of Bolts &amp; Washers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>At horizontal (end) laps of Sheets. At eaves when filler pieces are used. At ridge when sheets and ridge pieces are secured by the same bolt.</td>
<td>Depth of purlin plus 75mm</td>
<td>Short bolts: The number of sheets in one horizontal course plus two Long bolts: The number of sheets in one course less one.</td>
</tr>
<tr>
<td>2.</td>
<td>At eaves when filler pieces are not used. At ridge when sheets and ridge pieces are not secured by the same bolt.</td>
<td>Depth of purlin plus 75 mm.</td>
<td>Twice the No. of sheets in one horizontal course plus one.</td>
</tr>
<tr>
<td>3.</td>
<td>At intermediate purlin when horizontal laps do not occur.</td>
<td>Depth of purlin plus 75 mm.</td>
<td>The No. of sheets in one horizontal course plus one.</td>
</tr>
</tbody>
</table>

11.6.4 Wind Ties & Finish
The specifications shall be as described in 11.5.5 and 11.5.6.
11.6.5 Measurements
It shall be as described in 11.5.7 in addition, the end lap of the sheets under asbestos cement expansion joints where provided shall also be included in measurements. Gap between the sheets under expansion joint shall not be measured. The expansion joint sheets shall be measured for the finished work correct to one cm.

11.6.6 Rate
The rate shall include the cost of all the materials and labour involved in all the operations described above except otherwise stated. This includes the cost of roof sheets, polymer coated J or L hook bolts and nuts, bituminous and galvanized iron washers.

11.7 RIDGES AND HIPS OF NON-ASBESTOS HIGH IMPACT POLYPROPYLENE REINFORCED CEMENT
11.7 There shall be same manufacture for ridge, hips & sheet used for roof, unless specifically permitted in writing by the Engineer-in-Charge. The sections shall be free from cracks, chipped edges or corners or other damages.

The ridges shall be of the type specified in the item, such as:
1. One piece plain angular.
2. Serrated or plain wing adjustable.
3. Close fitting adjustable.
4. North light adjustable and appropriate for the corrugated or semi-corrugated roof which is to be covered' Plain Wing Angular type ridges can be used only if the slope of the roof is exactly 30°. Hips shall be of ‘under rated adjustable for hips’ sections.
5. Un-serrated adjustable.

11.7.1 Laying
The ridge sections shall be laid as per manufacturer’s instructions with the rolls of the two wings in the case of adjustable ridges fitting closely and with the serration of serrated ridges registering correctly with the sheets underneath. The stagger lapping or two wings of an adjustable ridge section and the laps between adjacent pieces on the same wing of the ridges shall be as per manufacturer’s instructions. The end portions of the wings of the adjustable ridges which project beyond the verges of the roof shall be cut and trimmed off neatly. Asbestos cement expansion joint ridge pieces shall be provided every 45 meters (approx.) of ridge where the latter is of the semi-corrugated serrated adjustable type. In laying hip pieces, serrations to suit the corrugations in the sheets below should be cut in them so that they will be a snug fit over the sheets.

11.7.2 Fixing of Ridges & hips
Fixing shall be as specified in para (a), (b), (c) given below
(a) The wings of ridges shall be fixed to the sheets below with the seam bolts and nuts 8 mm diameter polymer coated J or L hook bolts and nuts and bitumen and G.I. washers which fix the sheets to the purlins. In additions, in north light adjustable ridges the curves of the two wings shall be joined together at their crown with 8 mm dia polymer coated seam bolts and nuts, @ of 2 numbers/pair of wings. Each seam bolt shall be provided with one bitumen and a pair of G.I. washers.

(b) Where ‘Plain wing angular’ or ‘Plain wing adjustable’ ridges are used, the gaps formed by the roofing corrugations and the wings shall be filled with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 11.5 mm nominal size) upto the full length of the overlap. The exposed face shall be finished perpendicular to the sheeting.

(c) Wing of hips shall be fixed to the roof members below with the same 8 mm dia polymer coated or L hook bolts and nuts which fix the sheet to those members. In addition, they shall be secured to the sheets below with 8 mm dia polymer coated seam bolts, nuts and washers, so that taken together with hook bolts there shall be bolt on each wing at least every fifth corrugation of the sheet below in the case of ‘Corrugation’ and at least every second corrugation of the sheet below in the case of ‘semi-corrugated’ sheets. The seam bolts shall each be provided with one bitumen and a pair of G.I. washers.

11.7.3 Measurements
The measurements for ridges and hips shall be taken for the finished work along the centre line of the ridge and hip lines in length, correct to a cm. The laps in adjacent ridges or hip pieces shall not be
measured. The underlay of ridges under expansion joint pieces where the latter are provided shall however be measured.

11.7.4 Rate
The rate shall include the cost of all materials and labour specified above, excluding the cost of following:-
(1) The cost of required polymer coated hook bolts and nuts and their washers,
(2) The cost of supplying and fixing expansion Joint pieces,
(3) The cost of closing the gaps between plain ridge and the sheet corrugations with concrete. Item (a) above will be covered by the rate for the non-asbestos cement sheet roofing while items (b) and (c) will be paid for separately unless specifically included in the description of item of the ridge or hip item.

11.8 OTHER ROOFING ACCESSORIES OF NON-ASBESTOS HIGH IMPACT POLYPROPYLENE REINFORCED CEMENT (FIG. 11.5)
11.8.1 Accessories
The following are other accessories used in roof :-
(1) finishing pieces, eaves filler pieces, north light and ventilator curves, barge boards and expansion joint sheets
(2) ridge finials, cowl type ventilators, curved boards for north light, curves, roof light expansion joints for ridge and expansion joints for north light curves and
(3) ‘S’ type louver. The accessories shall be of the type appropriate for use with corrugated or semi corrugated sheets which form the roofing.
The accessories shall be of the same manufacture as the corrugated or semi-corrugated sheets used for the roof. The pieces shall be free from cracks, chipped edges or corners and other damages.

11.8.2 Laying & Fixing
These shall be laid and secured with the same polymer coated hook bolts which secure sheets to the roof members below where possible or with separate polymer coated hook bolts to the roof members below and/or with 8 mm dia polymer coated seam bolts, nuts and washers to the sheeting, generally as per manufacturers printed instructions and as ordered by the Engineer-in-Charge. ‘S’ type louvers shall be fixed to ventilators to timber, M.S. angle or flat iron verticals spaced not more than 1.65 meter centers. The laps of adjacent pieces over the verticals shall not be less than 10 cm. The upper flat of the top most rows of louvers shall be fixed to the vertical by 10 mm dia polymer coated bolts and nuts and bitumen and polymer coated washers. The lower flats of the top and intermediate rows of louvers and the flat of the louvers pieces below shall be secured together to the verticals behind by 10 mm dia G.I. separating bolts threaded at both ends and of suitable length. Each of these bolts shall be equipped with 2 pair of nuts, G.I. and bitumen washers. The louver flats of the lowest line of louvers shall also be fixed to the verticals at the proper distance from the same by the use of similar separating bolts and nuts.

11.8.3 Measurements
The accessories listed under group (1) in 11.8.1 shall be measured for finished work in length correct to a cm. Laps between adjacent pieces shall not be measured.

The accessories listed under group (2) in 11, 8, 1 shall be measured and paid for in number. This applies in the case of finial too where the unit shall consist of a pair of inter locking pieces.

The ‘S’ type louvers listed under group (3) in 11.8.1 shall be measured for the finished work in length of each row of louvers correct to a cm. The laps, between adjacent pieces of louvers will not be taken into account in the measurements.

11.8.4 Rate
(a) The rates for supplying and fixing, non-asbestos cement accessories listed in groups (1) & (2) of 11.8.1 shall include the cost of all materials and labour involved in all the operations described above bolts, nuts, washers and other fixing accessories but does not include the members.

(b) The rate for supplying and fixing roof lights shall not unless otherwise described in the item, include the glazing which shall be paid for separately.

(c) The rate for supplying and fixing ‘S’ type louvers shall include all fixing accessories such as ordinary and separating polymer coated bolts, nuts, and bitumen washers including drilling the holes for the
same in the vertical supporting member behind but shall not unless otherwise described in the item the cost of supplying and fixing the supporting members which shall be paid for separately.

11.9 PAINTING OF ROOF SLAB WITH HOT BITUMEN
11.9.1 Preparing the Surface for Painting
The surface for painting shall be thoroughly dry and cleaned with wire brushes and cotton or gunny cloth. All loose materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

11.9.2 Painting with Bitumen
a) The contractor shall bring the bitumen to site in its original packing and shall open and use it in the presence of the Engineer-in-Charge or his authorized representative & empty containers shall not be removed from the site until the painting job is completed and the Engineer-in-Charge has satisfied himself regarding the quantity of bitumen actually used.

b) The prepared surface shall be painted uniformly with bitumen of approved quality such as residual type petroleum bitumen of penetration 80/100, hot cut back bitumen or equivalent as per specifications of the manufacturer. The coat of bitumen shall be continued 15 cm along the vertical surfaces joining the roof & it shall be continued upto the drip courses in case of parapet walls.

c) Residual type petroleum bitumen of penetration 80/100 shall be heated to a temperature of not less than 180° C and not more than 190° C and shall be applied on the roof surface at not less than 180° C. Similarly, hot cut back bitumen shall be heated to a temperature of not less than 165° C and not more than 170° C and shall be applied on the surface at not less than 165° C.

d) Care shall be taken to see that no blank patches are left. The quantity of bitumen to be applied /10 square meters of roof surface shall be 17 kg, unless otherwise stipulated in the description of the item. It shall be carefully regulated so that the application is uniform at the stipulated rate of 17 Kg /10 square meters.

11.9.3 Spreading Sand
Immediately after painting, dry, clean sharp coarse sand @ of 60 cubic decimeter /10 sqm shall be evenly spread and leveled over the surface when the bitumen is still hot.

11.9.4 Measurements
The superficial area of the surface painted shall be measured in square meters. No deduction in measurements shall be made for unpainted areas of roof slab occupied by chimney stacks, roof lights etc. of areas each upto 40 sq. decimeter. The measurements of length and breadth shall be taken correct to a cm.

11.9.5 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

11.10 MUD PHUSKA TERRACING WITH BRICK TILE PAVING
11.10.1 Mud Phuska is a common type of insulating course in the roof used in hot dry region, where rainfall is not heavy it is cheap, regale durable and adds enough thermal insulation for maintaining relatively comfortable temperature in the interior
For mud phuska, selected layer shall be of a good quality earth suitable for making bricks not containing excessive clay or sand, free from stones, kankar, vegetable matter and other foreign matter, shall be collected and stacked at site. The soil shall not be collected from a locality infested with white ants. Before lying on the roof, the soil shall be made damp by adding water about 12 hours earlier. It shall be turned over with phawaras so as to break clods and to pulverize the same. Quantity of water to be added to the soil shall be carefully regulated so that the soil shall have optimum moisture content at the time of laying and compaction on the roof. The soil shall be laid on the roof to requisite thickness and slope, well compacted with wooden rammers and thappies, to obtain an even surface to correct slope. of the terrace shall be such that all rain water can be drained off. If the slope can not be given in the mud phuska layer, part of the slope can be given in such floor it self Average thickness of soil after compaction shall be as specified for the item.
Note: A practical way of determining the moisture content of soil suitable for giving good compaction is that the soil should contain that much quantity of moisture, which when a handful of soil is moulded with hand to the shape of a ball, it shall just retain its form. If the soil on moulding cannot retain its shape of a ball, moisture content is inadequate. On the other hand, if the ball can be plastically deformed on pressing with hand, the moisture content is on the high side.

11.10.2 Mud Plaster on mud Phuska:
(1) After laying the mud phuska, the surface shall be given a coat of mud plaster 25 mm thick and the plaster shall be allowed to dry and crack.

(2) The mud plaster shall be prepared from the same soil as for mud phuska.

(3) The dry soil shall be reduced to fine powder and mixed with water in a pit, adding fibrous reinforcing materials such as chopped straw (Bhusa) in proportion of 35 kg per cum of soil. The mixture shall be allowed to mature for a period of not less than 7 days. During this period it shall be worked over with feet and spades (Phawaras) at intervals so as to get pugged into a homogeneous mass free from lumps and clods.

(4) The mud mortar shall be puddle again very thoroughly just before use.

(5) The consistency of mud mortar shall be checked by taking it on a trowel and observing how it slides off the face of trowel. The mortar shall readily slide off the trowel and should not be as wet as to part on to large drops before falling. Alternatively slump test may be performed in accordance with IS 1199 & the slump should be about 70 mm.

11.10.3 Gobri Leaping
After the mud plaster has dried, the surface should be given a coat of gobri leaping so as to completely fill any crack that may have formed in the mud plaster. Mortar for gobri leaping shall be prepared by mixing equal quantities of fresh gobar and finely sieved clay and adding sufficient water to form a thin paste. The quantity of gobar used in gobri leaping shall not be less than 0.03 cum per 100 sqm of plaster area. Five percent of cut back bitumen by mass of dry clay may be added to improve upon the water proofing qualities.

11.10.4 Laying of Bricks Tile
After the gobri leaping has dried, brick tiles shall be laid using the minimum amount of plain mud mortar (without bhusa) as bedding so as to obtain correct slope and even surface of tile floors. Care shall be exercised to see that mud mortar does not rise into the vertical joints of the tiles more than 12 mm. The brick tiles shall be either flat tile bricks of class designation 100 or machine moulded tile bricks of class designation 125 conforming to IS 2690 (Part I) as per the nomenclature of the item. The tiles shall be laid such that the thickness of joints shall not be less than 6 mm and more than 12 mm in width. After the tiles are well set and bedding mortar has dried, joints of the tiles shall be grouted with cement mortar of mix 1:2:3 (1 cement: 3 fine sand) such that all the joints of tiles are completely filled with mortar and the joints should be finished neat. Cement used for the mortar shall be mixed with 2% of integral water proofing compound which should conform to IS 2645.

11.10.5 Curing
As soon as cement grouting obtains initial set, the surface of the brick tile floor shall be covered with wet gunny bags, hessian cloth or wet sand to prevent quick drying. After 8 to 12 hours, the brick tile floor shall be cured by frequent sprinkling of water on the surface for a period of 7 days. After curing has been done, the surface shall be swept clean. The tile surface as completed shall be even and true to slopes of 1 in 48 or as specified and should be leak proof.

11.10.6 Measurements
Length and breadth shall be measured correct to a cm. The measurements shall be taken for the finished work, (mud phuska terracing of stipulated thickness with mud plaster, gobri leaping and tile paving and grouting) over the tiled surface, in superficial area. No deductions in measurements shall be made for either openings or recesses for chimney stacks, roof lights or khurras, of area upto 0.40 sqm. No extra shall be paid either for any extra materials or labour involved in forming such openings, recesses etc. For areas exceeding 0.40 sqm deductions will be made in the measurements for the full opening but extra shall be paid for any extra labour, materials etc. in forming such openings. For plus or minus deviation from the average thickness stipulated for the mud phuska in the item, payments will be
adjusted in the rate admissible to the contractor for the relevant schedule item provided that such deviations were authorized by the Engineer-in-Charge in writing.

11.10.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

11.11 CEMENT CONCRETE GOLA
11.11.1 The specifications for concrete shall be the same as described in subhead 3.0 of concrete work.

11.11.2 Gola
A chase of 75 mm wide and 75 mm deep shall be cut in the parapet wall just above the junction of mud phuska or lime concrete with parapet wall and it shall be filled with cement concrete grade m15 or 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 10 mm and down gauge) the external face finish with a slope of 1: 0.75 and the exposed surface of the Gola shall be plastered with cement mortar 1: 3 (1 cement: 3 fine sand). Expansion joint at every 3.5 to 4.5 meters shall be provided and filled with bitumen filler. The bitumen filler shall be prepared by mixing bitumen, cement and coarse sand in the ratio of 80: 1: 0.25 (80 kg of hot bitumen: 1 kg of cement and 0.25 cum of coarse sand).

11.11.3 Curing
The finished surface shall be cured for at least 7 days.

11.11.4 Measurements
The length of the finished Gola shall be measured at its Junction with the wall face correct to a cm. No deduction shall be made in measurements for gaps for water outlets.

11.11.5 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above including the cost of bitumen filler in expansion Joint. The rate includes for all turnings and rounding’s at all the corners and risers.

11.12 KHURRAS
11.12.1 The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm unless otherwise specified in the description of the item and shall be made of cement concrete grade m15 or 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

11.12.2 Laying
(a) A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminum foil of 32 SWG) shall be laid under the khurras and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

(b) The concrete shall be laid to a size greater than the stipulated size of the khurras in such away that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

(c) The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement: 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the Engineer-in-Charge.

(d) In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the Engineer-in-Charge. Iron gratings, shall be of overall size 20 x 25 cm with an outer frame of 15 x 3 mm M.S. flat to which 4 No’s M.S. bars of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm. or as directed by the Engineer in Charge.
11.12.3 Measurements
Khurras shall be counted in numbers.

11.12.4 Rate
The rate is for each completed khurra of the specified size and is inclusive of the cost of all materials and labour in forming the khurras and outlet opening as described above, except for iron gratings which shall be paid for separately.

11.13 RED OR WHITE SAND STONE ROOFING
11.13.1 Sand Stone Slabs
This shall be hard, even, sound, and durable and shall conform to standards as detailed in subhead 6.0 of stone work. Slabs shall have been sawn or chiseled in a plane parallel to the natural bed of the stone. The slabs shall be rough chisel dressed on the top so that the dressed surface shall not be more than 6 mm from a straight edge placed on it. The edges of the depressions or projections shall be chisel dressed in a slant, so that surface does not have sharp unevenness. The sides shall also, be chisel dressed to a minimum depth of 20 mm so that the dressed edges shall at no place be more than 3 mm from a straight edge butted against it. The thickness of the slab shall be uniform and as specified in the item with a permissible tolerance of 2 mm. The slabs shall be uniform in length, the length being 5 to 8 mm less than the centre to centre spacing of the supporting wooden joists (Karries) or RCC battens. Unless the design requires some other shape the slabs shall be rectangular. The width of the slabs may vary unless otherwise stipulated & shall not be less than 40 cm.

11.13.2 Rafter Spacing
The maximum spacing of rafters (karries) or RCC battens supporting the slabs shall not exceed figures given in Table G

<table>
<thead>
<tr>
<th>Thickness of Slab</th>
<th>Maximum Spacing of Rafters</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 mm</td>
<td>52.5 cm.</td>
</tr>
<tr>
<td>45 mm</td>
<td>60 cm.</td>
</tr>
<tr>
<td>50 mm</td>
<td>68 cm.</td>
</tr>
</tbody>
</table>

The bearing of slabs over the supporting rafts karries shall not be less than 30 mm. Where a raft karry supports a slab from one side only, the bearing of such slab shall be for full width of the raft. For bearing over the wall, the stone slabs shall be bedded over a layer of cement mortar 1: 4 (1 cement: 4 coarse sand) of thickness not less than 12 mm.

11.13.3 Laying
The slabs shall be washed clean and wetted before being laid and jointed in cement mortar 1:4 (1 cement: 4 coarse sand). The width of joints shall not be more than 8 mm not less than 5 mm. The top joints shall be finished flush and ceiling joints pointed with the cement mortar 1:3 (1 cement: 3 fine sand).

11.13.4 Finish
The finished surface shall be truly leveled or slopped as shown in the plan or as directed by the Engineer-in-Charge. It shall be cleaned off all mortar droppings and cement markings both on top and on the under side.

11.13.5 Curing
The slabs and their joints shall be kept wet during progress of work and for 7 days after completion.

11.13.6 Measurements
Length and width of finished stone slab work including bearing shall be measured correct to a cm. The area shall be calculated in sqm correct up to two places of decimal.

No deduction in area shall be made for openings in roof slab for chimney, stacks, roof lights etc of neither area upto 40 square decimeter nor any extra shall be paid for extra labour, materials etc. involved in cutting and wastage, in forming such openings. For openings exceeding 40 sq. decimeter in area, deduction shall be made in measurements for the full opening but extra shall be paid for extra labour, material etc. required in forming such openings.
11.13.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

11.14 WOODEN CEILING
Following materials are required for wooden ceiling:-
(a) Board
(b) Timber frame
(c) M.S screws

11.14.1 Boards
(a) Boards shall be of the class of timber, of finished thickness of board shall be as specified in the description of the item, board shall be in accordance with the general specifications for wood work. Only selected boards of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of boards selected for use shall not be less than 100 mm nor more than 150 mm.

(b) The specific width of boards once selected within above two limits shall be maintained through out and shall not be varied except in the first and last lines of board’s adjustment to the two walls, where remaining odd width shall be adjacent equally on both sides. The maximum length of the board in the finished work shall be 180 cm. The minimum length of board in the finished work shall be such that it will span at least two spacing of the supporting frame work except where shorter lengths are unavoidable, depending on the arrangements of the lines of heading joints which shall be carried out to the pattern ordered by the Engineer-in-Charge. The boards shall be planed true on the exposed side.

(c) Unless stipulated otherwise in the description of the item, the longitudinal joints of the boards shall be tongued and grooved, while the heading joints shall be of the square butt type and shall occur under the centre line of the supporting joint. Heading joints in adjacent boards shall not be placed over the same joists, those in alternate boards being arranged in the same line, except where the joints are to be concealed by headings.

11.14.2 Frame
Section of timber frame shall be as specified in the description of the item or as ordered by the Engineer-in-Charge shall be provided. The width of the frame scantling shall not be less than 50 mm. The arrangements and spacing of the frame scantling shall be as per design furnished. The frame shall be given two coats of approved preservative paint before the boarding is screwed. The frame and paints thereof shall be paid for separately unless specifically included in the description of the item. M.S. angles or other sections shall be used for suspending the frame and paid for separately. The bottom surface of the frame shall be checked and corrected to true plans and slopes.

11.14.3 Mild Steel Screws
Screws shall be got approved from the Engineer-in-Charge before fixing and they shall be of the slotted counter sunk head type of length not less than the thickness of the board plus 20 mm. The designation number shall not be less than 9 for screws of length 40 to 50 mm and shall not be less than 6 for screws of length 25 to 35 mm.

11.14.4 Fixing
The outer lines of boards shall be accurately fixed, parallel and close to the wall. Each subsequent plank shall be carefully jointed up. The boards shall be fixed to the frame scantling above with two screws at each of frame and one at every intermediate joist. The screws shall be counter sunk and the screw holes filled with putty or sloping out wax.

The unexposed faces of planks shall be painted with wood preservative before fixing.

11.14.5 Finishing
The exposed side of the boards shall be truly level and plane. The joints shall be truly parallel, and/or perpendicular to the walls. The beadings shall then be fixed to the ceiling, to the size and pattern required. These shall be measured and paid for separately unless specifically included in the description of the ceiling item.
11.14.6 Measurements
Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01 sqm. The superficial area of the finished work ceiling shall be measured in square meters.

No deduction in measurements shall be made for opening of areas upto 0.40Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.40 sqm in area, deductions in measurements for the full opening will be made and in such case any labour involved in making these opening shall be paid for separately in running meters.

Wooden ceiling of boarding fixed to curve surfaces in narrow widths shall be measured and paid for separately and shall include making the joints to proper splay. Circular cutting and waste shall be measured and paid for separately in running meters.

11.14.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

11.15 CEILING WITH FIBRE INSULATING BUILDING BOARDS
11.15.1 Insulating Building Boards
The insulating building boards shall be of approved quality as per IS code 3348 and, unless otherwise this, shall have square edges. The dimension shall be subjected to the tolerances given in the table below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type of Board</th>
<th>Nominal Thickness mm</th>
<th>Tolerance on Thickness mm</th>
<th>Length Cm</th>
<th>Width Cm</th>
<th>Tolerance on length and width</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Fiber insulation board, ordinary or flame retardant type</td>
<td>9</td>
<td>± 0.75</td>
<td>365, 300</td>
<td>180, 150</td>
<td>120 cm and below ± 3 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>± 0.75</td>
<td>270, 240</td>
<td>120, 100</td>
<td>Above 120 cm ± 6 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
<td>± 1.00</td>
<td>210, 180</td>
<td>90, 60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25</td>
<td>± 1.25</td>
<td>150, 120</td>
<td>45 and 30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100, 90</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60, 45</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and 30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11.15.2 Frame
Frame of the class of timber and section specified in description of the relevant item or as ordered by the Engineer-in-Charge shall be provided. The width of the scantlings provided shall be sufficient to provide a minimum nailing surface of 50 mm. The longitudinal and header scantlings shall be so arranged that:

(1) The boards can be fixed to form the panel arrangements required as per drawings or as ordered by the Engineer-in-Charge.

(2) The longitudinal scantling to which the boards are per mainly fixed are spaced at 30 to 45 cm centers, the actual spacing selected depending on the width of the cut board in the panel arrangement.

(3) All edges of the cut board units are supported either on the longitudinal scantlings or on the header scantlings or on both.

The frame shall be given two coats of approved preservative paint (to be paid for separately) before the board is nailed on. M.S. angles or other sections shall be used for suspending the frame and will be paid for separately. Where the joints in the board are to be covered with beadings the frames should allow 3 to 6 mm for space between boards. The frame and painting thereof shall be paid for separately unless specifically included in the description of the ceiling item. The bottom surface of the frame shall be checked and corrected to true planes and slopes.

11.15.3 Nails
The sheets shall be fixed to the frame scantling with G.I. headless nails 2.24 mm dia when the joints are to be left exposed. Where the joints will be covered with headings, the sheets are to be fixed to the
frames scantlings with G.I. felt headed (clout) nails 2.5 mm dia. The length of the nails shall generally be equal to thickness of sheet plus 25 mm so that their grip on the framing members will not be less than 25 mm.

11.15.4 Fixing
The boards shall be laid with lengths parallel to all joints centered over the framing members. Where joints are to be covered, the boards may be spaced 3 to 6 mm apart as described in the respective manufacturers’ specifications. Where joints are to be left exposed the sheets shall be butt laid with their edges abutting in moderate contact, but without having to force them into place. The boards shall be supported and held tight to the frame with timber pieces the later being moved outwards as the nailing proceeds. The boards are first nailed to the intermediate framing member proceeding from the centre of the board outwards, the edges being nailed last.

Where the joints are to be left exposed, the outer rows of nails are placed at 10 cm centers and about 12 mm from the edge of the sheet. In the rows in the middle of the sheets, the nails are placed 20 cm apart. The nails should be counter sunk in the under side of board with a suitable punch. Care shall be taken in driving the nails so that the sheets are not marked by hammer blows. Where the joints are to be covered with headings, felt headed (clout) nails shall be used instead of nails without head. The spacing of the nails in the interior rows in boards shall be the same as in the preceding para. In the outer rows at edges to be covered by headings, the nails will be spaced at 20 cm centers in each row with the nails staggered. The headings will then be fixed over the sheets with screws at 20 cm centers in each row with the screws in the two rows staggered and passing through beading, sheet and framing so that ultimately the spacing of the fixing (nails and screws taken together) in each row will be at 10 cm centers so far as the sheets and frames are concerned.

11.15.5 Finishing
The exposed side of the board shall be truly level and plane without any local bulges or sags. The joints shall be truly parallel and/or perpendicular to the walls. The width of joints shall be uniform and care shall be taken to see that the uniformity of colour of the sheets is not spoiled during the fixing operations.

Where the joints are required to be covered, headings of size, pattern and material as approved by Engineer-in-charge are fixed with screws. These shall, however, be measured and paid for separately, unless specifically included in the description of the ceiling item. The ceiling shall be treated with distemper or painting if so required but such surface treatment will be paid for separately, unless specifically included in the description of the ceiling item.

11.15.6 Measurements and Rate
These shall be the same as described in para 11.14.6 and 11.14.7 is applicable

11.16 PARTICLE BOARD /MULTIPURPOSE CEMENT BOARD CEILING
11.16.1 Boards
(a) Particle Board: Particle board flat pressed 3 layers medium density shall be graded particle board grade-1 conforming to IS 3087 of specified thickness. The specifications for particle board shall be same as in sub head 8.0 of wood work and PVC work.

(b) Multipurpose Cement Board: (High Pressure Steam cured). This shall be conforming to IS 14862 and of thickness specified in the item.

11.16.2 Frame
The specifications for cutting and chamfering etc. shall be as described in para 11.15.2 except that the maximum spacing of the longitudinal scantlings shall be 40 cm centers.

11.16.3 Nails and Fixing
The specifications shall be the same as in para 11.15.3 and 11.15.4 are applicable.

11.16.4 Finishing
The specifications as in para 11.15.5 shall apply except that normally no surface treatment like painting, varnishing, etc. is necessary.
11.16.5 Measurements and Rate
These shall be the same as under para 11.15.6.

11.17 PLAIN/SEMI PERFORATED PARTICLE BOARD TILES CEILING

11.17.1 Frame
The frame work shall consist of anodized aluminum “T” sections for main runners /cross runners of size specified in the item with anodic coating of 15 micron and perimeter wall angle of anodized aluminum section of size specified by the Engineer-in-charge with anodic coating of 15 micron fixed to the wall with M.S. screws 50 mm long and PVC raw plugs. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The frame work shall be suspended from ceiling by level adjusting hangers made of 6 mm dia. M.S. rods fixed to slab by means of MS ceiling cleats. The ceiling cleats shall be fixed to the slab by means of mechanical dash fasteners 6 mm dia and 50 mm long. MS hangers and ceiling cleats shall be painted with a coat of yellow zinc chromate primer and two coats of synthetic enamel paint.

11.17.2 Ceiling Tiles
Ceiling tiles shall be of 12 mm plain/semi perforated or with design BWP type phenol formaldehyde synthetic resin bonded particle board conforming to IS 3087 of required size. Tiles shall be finished with a coat of, aluminum primer on both side and edges and two coats of synthetic enamel paint of approved quality and shade on exposed faces of the tiles.

11.17.3 Fixing of Ceiling Tiles
The ceiling tiles shall be placed over the aluminum frame and fixed to the frame with help of 25 mm long CP brass screws with minimum 2 screws on each side of the grid. The CP brass screws shall be counter sunk star head screws.

11.17.4 Measurements
Length & breadth of the finished ceiling shall be measured correct to a centimeter. The area shall be calculated in square meter correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materials or labour involved in making such openings.

11.17.5 Rate
The rate shall include the cost of all the materials and labour involved in all the operation described above including scaffolding etc. Aluminum frame work mentioned in para 11.19.1 will be paid for separately unless otherwise stipulated in the description of the items.

11.18 TRANSLUSCENT WHITE ACRYLIC PLASTIC (PMMA) SHEET CEILING
11.18.1 Frame It shall be as para 11.17.1

11.18.2 Ceiling Tiles
These shall be made of translucent white acrylic plastic sheet conforming to IS 14753 of thickness as specified in the item.

11.18.3, Fixing, Measurements & Rate same as per para 11.17.3, 11.17.4, 11.17.5 respectively are applicable.

11.19 PLASTER OF PARIS (GYPSUM ANHYDROUS) CEILING OVER WOODEN STRIPS
11.19.1 Frame
Specified wood shall be used in frame work if the roof is sloping then wooden battens of suitable section (depending upon the span and load to be carried) shall be firmly fixed as main supports, to the under side of the tie beams of the trusses at required spacing by means of bolts and nuts of proper size. If roofs are flat then the battens shall be securely fixed to the walls and pillars by holding down bolts and shall be fastened to the slabs above with iron straps of suitable sections and encroached therein. Cross battens of 50 x 40 mm sections at 40 cm centers or so, shall then be fixed at right angles to the main battens. The frame work shall be treated with approved wooden preservative before fixing. The underside of the frame work shall be true to planes and slopes. The frame work for ceiling shall be paid for separately unless specifically included in the description of the ceiling item.
11.19.2 Wooden Strips
Wooden strips of size 25 x 6 mm of Teak wood/Sal wood, (unless otherwise stipulates specifically in the description of the item) shall be fixed to the cross battens, in the parallel rows with gaps of 10 mm in between adjacent rows, by means of felt headed (clout) nails. The strips shall be fixed butt jointed and not overlapped. The joints shall be staggered. The minimum length of strips to be used shall be 1.5 m spending upon the length of strips required.

11.19.3 Rabbit Wire Mesh
Rabbit Wire mesh shall then be fixed to the underside of wooden strips and their junctions with the battens with nails at pitch of 15 to 20 cm as ordered by the Engineer-in-Charge. The rabbit wire mesh shall be straight, tight and perfectly true to planes and slopes and without any sagging and shall be slightly below the underside of the laths to allow the plaster to encase the metal round.

11.19.4 Plaster of Paris:- The quality shall be as given below
(a) The plaster of Paris shall be of the calcium-Sulphates semi-hydrate variety.
(b) Its fineness shall be such that when sieved through a sieve of IS sieve designation 3.35 mm for 5 minutes the residue left on it after drying shall be not more than 1% by weight.
(c) It shall not be too quick setting. Initial setting time shall not be less than 13 minutes.
(d) The average compressive strength of material determined by testing 5 cm cubes after removal from moulds, after 24 hours and drying in an oven at 40° C till weight of the cubes is constant, shall not be less than 84 kg per sqm.

11.19.5 Applications:- Plaster of paris shall be applied for ceiling as given below
(i) The material will be mixed with water to a workable consistency.
(ii) Plaster of Paris shall be applied to the underside of the laths over the rabbit wire mesh in suitable sized panels and finished to a smooth surface by steel trowels.
(iii) The plaster shall be applied in such a manner that it fully fills the gaps between the laths and the thickness over the laths is as specified in the description of the item.
(iv) The joints shall be finished flush to make the ceiling in one piece. The finished surface shall be smooth and true to plane, slopes or curves as required.

11.19.6 Measurements
(a) Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made to openings of areas upto 40 square decimeter nor shall extra payment be made either for any extra material or labour involved in forming such openings.
(b) For openings exceeding 40 square decimeter in area, deduction in measurements shall be made but extra payment will be made for any extra material or labour involved in making such openings.
(c) Curved surfaces shall be measured and paid for separately from flat surfaces. The work shall be deemed to comprise of flat surfaces only unless specifically stated otherwise in the description of the item.
(d) Any sunk or raised moulding in the plaster shall be measured and paid for separately, deductions being made from plastering on ceiling only if the width exceeds 15 cm. Ceiling at a height greater than 5 meters shall be so described and measured separately stating the height.

11.19.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc The frame work mentioned in para 11.19.1 supporting the ceiling will be paid for separately unless otherwise stipulated in the description of the item. The rate does not include for any raised or sunk moulding or for any patterned finishing of the surface which will be measured and paid for extra over the plaster work.

11.20 RAIN WATER SPOUTS
The sectional area of rain water spouts provided shall be generally @ of 1 square cm per 70 to 80 square decimeter of roof area drained. However in locations subject to excessive and high intensities of rainfalls, the area of spouts provided may be suitably increased to suit local conditions. No spout shall be less than 80 mm in diameter. The spacing of spouts shall be arranged to suit the position of openings in the wall.
11.20.1 Stone Ware Spouts
The stone ware pipe shall be perfectly sound, free from fine cracks, imperfections of glazing etc. They must be straight cylindrical and of standard nominal diameter, length, depth of socket as given in IS 651. Full length of pipes shall be used on the work. They must be thoroughly salt glazed inside and outside shall generally conform to IS 651. The spouts shall be 100 mm in diameters and 60 cm long.

11.20.2 Fixing: These shall be provided at the mouths of khurras and shall be fixed in cement mortar 1:3 (1 cement: 3 coarse sand) with the socket embedded in the masonry and the spigot end projecting outside. The masonry around the pipe and socket shall be thoroughly wetted and the holes shall be given a coat of cement mortar around. The S.W. pipe shall then be inserted and fixed with a surround of mortar. In case the hole has become much larger than the size of the pipe, cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) shall be used to fill in the annular space. The spouts shall slope downward at the rate of 1 in 6. The projection outside the wall shall be uniform and not less than 40 cm. The entrance into the pipe shall be smoothly rounded to meet the vertical plane through the centre line of the spouts is at right angles to the plane of the wall. Spouts in a row shall be true to line.

11.20.3 Measurements: The spouts shall be measured in numbers.

11.20.4 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding.

11.21 CAST IRON RAIN WATER PIPES
11.21.1 Cast Iron Pipes
CI Pipes shall conform to IS 1230, pipe shall be smooth and cylindrical. These shall be sound and of uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall be reasonably square to their axes.

11.21.2 Dimensions
C.I. rain water pipes shall be of the dia specified in the description of the item and shall be in full length of 1.8 meter including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall be in each case be with socket. The pipes shall be supplied without ears unless otherwise specifically mentioned. The pipes supplied shall be factory painted (with a tar base composition) both inside and outside which shall be smooth and tenacious. Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The sizes, weights, sockets and tolerances of pipes shall be as shown in table below:-

<table>
<thead>
<tr>
<th>Table - I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions and Weight of C.I. Rain Water Pipes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nominal size of pipes</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Nominal size of pipes</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Internal diameter in mm</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. PIPE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) External diameter in mm</td>
<td>53</td>
<td>79</td>
<td>104</td>
<td>130</td>
<td>156</td>
</tr>
<tr>
<td>Tolerance in mm</td>
<td>± 3</td>
<td>± 3</td>
<td>± 3.50</td>
<td>± 3.50</td>
<td>± 4.00</td>
</tr>
<tr>
<td>(b) Thickness in mm</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Tolerance in mm</td>
<td>± 1</td>
<td>± 1</td>
<td>± 1</td>
<td>± 1</td>
<td>± 1</td>
</tr>
<tr>
<td>(c) Nominal weight of 1800 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>long pipe without ears in kg</td>
<td>7.50</td>
<td>11.00</td>
<td>14.00</td>
<td>20.00</td>
<td>26.00</td>
</tr>
<tr>
<td>Tolerance in weight</td>
<td>(-) 10%</td>
<td>(-) 10%</td>
<td>(-) 10%</td>
<td>(-) 10%</td>
<td>(-) 10%</td>
</tr>
<tr>
<td>Tolerance in length in mm</td>
<td>± 13.00</td>
<td>± 13.00</td>
<td>± 13.00</td>
<td>± 13.00</td>
<td>± 13.00</td>
</tr>
<tr>
<td>2. SOCKET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Internal diameter in mm</td>
<td>63</td>
<td>89</td>
<td>114</td>
<td>139</td>
<td>167</td>
</tr>
<tr>
<td>Tolerance in mm</td>
<td>± 3.00</td>
<td>± 3.00</td>
<td>± 3.00</td>
<td>± 3.00</td>
<td>± 3.00</td>
</tr>
<tr>
<td>(b) Thickness in mm</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Tolerance in mm</td>
<td>± 1.00</td>
<td>± 1.00</td>
<td>± 1.00</td>
<td>± 1.00</td>
<td>± 1.00</td>
</tr>
</tbody>
</table>
### Nominal size of pipes

<table>
<thead>
<tr>
<th>Internal diameter in mm</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) Internal depth in mm</td>
<td>60</td>
<td>65</td>
<td>65</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Tolerance in mm</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
<td>± 10</td>
</tr>
</tbody>
</table>

Note:  
(a) All dimensions are in mm.  
(b) Pipes weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of this standard.  
(c) The above table applies only to rain water pipes fixed on wall face.  
(d) For pipes and fittings which are to be embedded in masonry, specifications shall correspond with those of pipes for soil, waste, and vent pipes. For their weights, specifications under chapter 19.0 shall be referred to.

### 11.21.3 Fixing and Jointing

Pipes shall be either fixed on face of wall or embedded in masonry, as required in the description of the item.

(a) Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning and painting of pipes.

Note: Where G.I. sheet clamps are not provided, M.S. sheet clamps of 3 mm thick and 20 mm wide shall be used for making the clamps.

(b) The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The annular space between the socket and the spigot shall be filled with a few turns of spun yarn soaked in neat cement slurry. These shall be pressed home by means of caulking tool. More skins of yarn shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45° sloping up. The joints shall be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

(c) If the pipes are to be embedded in masonry then these shall be fixed in masonry work as it proceeds. In such cases care shall be taken to keep the pipes absolutely vertical or to the line as directed by the Engineer-in-Charge. The pipe shall have a surrounding of 12 mm minimum thickness of mortar at every portion of the external surface. The mortar shall be of the same mix as is used in the masonry. The joint shall be caulked with lead as soon as the next length of pipe is placed in position. The open end (socket end) of the pipe shall be kept closed till the next length is fitted and jointed, to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe. The depth of lead from the lip of socket shall be 25 mm minimum. In case of 100 mm 75 mm and 50 mm dia pipes, the quantity of lead required per joint shall be 1.00 kg, 0.66 kg and 0.50 kg respectively purpose of reckoning theoretical Consumption. In order to ensure that required quantity of lead is poured into the joint and to control wastage of lead, at the beginning, three or four samples shall be made and the quantum of lead, per joint approved by the Engineer-in-Charge. The actual consumption of lead should be within ± 5% of the approved sample job subject to the provision that a variation of ± 20% shall be allowed over the theoretical quantity of lead due to dimensional tolerances allowed as per Indian Standards. This variation includes allowances of wastage also.

(d) The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25 mm from the lip of the socket for the lead. The joint shall then be lead caulked as described in detail under jointing of S.C.I soil, waste and vent pipes.
11.22 CAST IRON ACCESSORIES FOR RAIN WATER PIPES

11.22.1 C.I. Fittings

C.I. accessories such as bends of various degrees, heads, and offsets of different projections, branches and shoes shall conform to IS 1230. Bends shall be of the nearest standard degree as actually required at site. Heads shall be of the flat or corner type as required. Offsets shall be of the projection as stipulated in the description of the item. Branches shall be single or double as described in the item and shall be of the nearest standard degree as actually required. Standard shoes shall be of overall vertical length, 180 mm for 75 mm dia., 205 mm for 100 mm dia and 275 mm for 150 dia sized pipe from top of socket to lowest tip of shoe. Shoes of longer lengths if used shall be in lengths 300 mm, 375 mm, 450 mm, or 600 mm from top of socket to lowest tip of shoe of as actually required at site.

11.22.2 Dimensions

The fittings shall be of the diameter specified in the description of the item. The thickness of the fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise specifically mentioned in the item. The fittings shall be factory painted with a tar basis composition both inside and outside which shall be smooth and tenacious. Every fittings shall ring clearly when struck all over with a light hard hammer. The fittings shall be of standard size and their individual weights shall conform to the weights given in the table below.

| TABLE- J Weight of C.I. Rain Water Pipe Fittings. |

<table>
<thead>
<tr>
<th>S.No</th>
<th>Description</th>
<th>75 mm dia (weight in kg)</th>
<th>100 mm dia (weight in kg)</th>
<th>150 mm dia (weight in kg)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bends (Plain)</td>
<td>3.20</td>
<td>4.50</td>
<td>9.10</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>Offsets (Plain)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>(a) 55 mm projection</td>
<td>2.70</td>
<td>5.00</td>
<td>8.20</td>
<td>Each</td>
</tr>
<tr>
<td>2.</td>
<td>(b) 75 mm projection</td>
<td>3.20</td>
<td>5.50</td>
<td>9.10</td>
<td>Each</td>
</tr>
<tr>
<td>2.</td>
<td>(c) 115 mm projection</td>
<td>4.10</td>
<td>5.90</td>
<td>9.50</td>
<td>Each</td>
</tr>
<tr>
<td>2.</td>
<td>(d) 150 mm projection</td>
<td>4.50</td>
<td>6.40</td>
<td>10.40</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>(e) 225 mm projection</td>
<td>5.00</td>
<td>7.30</td>
<td>11.80</td>
<td>Each</td>
</tr>
<tr>
<td>2.</td>
<td>(f) 300 mm projection</td>
<td>6.00</td>
<td>8.60</td>
<td>12.70</td>
<td>Each</td>
</tr>
<tr>
<td>3</td>
<td>Branches (Plain)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single</td>
<td>5.00</td>
<td>7.30</td>
<td>14.50</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>Double</td>
<td>6.80</td>
<td>10.00</td>
<td>19.10</td>
<td>Each</td>
</tr>
<tr>
<td>4</td>
<td>Standard shoes (Plain)</td>
<td>3.20</td>
<td>4.10</td>
<td>8.60</td>
<td>Each</td>
</tr>
<tr>
<td>5</td>
<td>Longer shoes (Plain)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 300 mm</td>
<td>3.20</td>
<td>5.00</td>
<td>-</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>(b) 375 mm</td>
<td>4.10</td>
<td>5.50</td>
<td>-</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>(c) 450 mm</td>
<td>5.50</td>
<td>6.40</td>
<td>-</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>(d) 600 mm</td>
<td>7.30</td>
<td>8.60</td>
<td>-</td>
<td>Each</td>
</tr>
<tr>
<td>6</td>
<td>Heads</td>
<td>6.40</td>
<td>6.80</td>
<td>11.30</td>
<td>Each</td>
</tr>
<tr>
<td>7</td>
<td>Extras:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) For ears cast on any fitting and short pipes</td>
<td>0.90</td>
<td>0.90</td>
<td>1.35</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>(b) For inspection doors fitted on any fitting</td>
<td>1.80</td>
<td>1.80</td>
<td>2.25</td>
<td>Each</td>
</tr>
</tbody>
</table>

Note: (a) The above table applies only to rain water fittings which are part of pipe lines fixed on wall face. Permissible Tolerance in weight of fittings shall be 5%.
(b) For fittings to be used with pipe lines to be embedded in masonry, specifications shall correspond with those of pipe fittings for soil, waste and vent pipes. For their weights. Specifications under S.C.I, soil, waste and vent pipes may be referred to.

11.22.3 Fixing and Jointing shall be as specified in para 11.23.3 are applicable.

11.22.4 Measurements

The fittings shall be measured by numbers. Where longer shoes are used in lieu of standard shoes specified in the description of the item, they shall be measured as standard shoes of 180 mm, 205 mm
and 275 mm for 75 mm dia, 100 mm dia and 150 mm dia respectively in number and the extra lengths of the shoes shall be measured and paid for under the corresponding size of pipes.

11.22.5 Rate
The rate shall include in the case of fittings fixed on the face of wall, the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing the M.S. holder bat clamps in walls and the anchoring concrete. Unless otherwise specified in the description of the item, the rate shall apply for fittings without access doors. In the case of fittings forming part of a rain water pipe line embedded in masonry, the rate shall be for supplying and embedding the fittings in masonry but shall not include for the jointing and lead caulking which shall be paid for separately.

11.23 THERMAL INSULATION FOR ROOFING
11.23.1 with Cellular Concrete
(a) Types and Grades:
Cellular concrete is a light weight concrete formed by producing gas or air bubbles in cement slurry or a cement sand slurry. Cellular concrete shall conform to IS 6598 and shall be of following two types depending on the manner of manufacture.

(i) Type I: High pressure steam cured (auto-calved) materials in the form of precast blocks.
(ii) Type II: Materials cured under natural conditions (that is under ambient pressure and temperature) by water. The material may be either cast in situ or may be in the form of precast blocks.

These two types of the material shall have three grades, namely:-
Grade A - Light weight cellular concrete;
Grade B - Medium weight cellular concrete and;
Grade C - Heavy weight cellular concrete.

11.23.1.1 Materials
(a) Aggregate: A variety of siliceous fines, such as ground quarts sand shale, fly ash and granulated slag may be used in the manufacture of cellular concrete.
(b) Water and cement shall conform to para 2.1.1 and 2.1.2 of of mortar specification .
(c) Gassing Agents: Organic foaming agents based on resin soap, glue, surface active agents, or fine aluminum powder, zinc, dust, calcium carbide, calcium by pocheride etc. may be used for gassing the concrete.

11.23.1.2 Dimensions
The dimensions of the type I and type II precast cellular concrete. Block shall be either 50 or 60 cm in length, 20, 25 or 30 cm in width and 7.5, 10, 15, 25 or 40 cm in thickness.
(a) Tolerance: A tolerance of ±3 percent shall be allowed on width and height and ±1 percent on thickness.

11.23.1.3 Requirement for Cellular Concrete

<table>
<thead>
<tr>
<th>S. No</th>
<th>Characteristics</th>
<th>Grade A</th>
<th>Grade B</th>
<th>Grade C</th>
<th>Test reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Density in Kg/cum</td>
<td>Upto 320</td>
<td>321 to 400</td>
<td>400 to 500</td>
<td>IS 5688</td>
</tr>
<tr>
<td>2.</td>
<td>Crushing Strength in kg/sq. cm.</td>
<td>Type I: 7.0</td>
<td>12.0</td>
<td>20.0</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type II: 2.5</td>
<td>4.5</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Thermal conductivity in Kw/cm deg. c</td>
<td>at 50 deg. c mean Temperature</td>
<td>0.7</td>
<td>0.85</td>
<td>1.0</td>
</tr>
<tr>
<td>4.</td>
<td>Capillary absorption not to exceed 20% in case of type I cellular concrete when tested as per, Appendix A of IS 6598.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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11.23.1.4 *Sampling:*
In a consignment, cellular concrete of the same type and grade and manufactured approximately in the same period shall be grouped to form a lot. If it is in the form of blocks, a lot shall be made up of not more than 1000 blocks. If the material is in situ, not more than 10 tons of materials shall constitute a lot. If the material is transported in Lorries and received as such, the material in lorry (or vehicle load) & may conveniently be termed as lot. Each lot shall be tested for all the requirements separately. If the lot is made up of precast blocks, the number of sample blocks to be tested shall be selected at random as per the table below:

<table>
<thead>
<tr>
<th>Lot Size</th>
<th>Sample size (block to be sampled) (n)</th>
<th>Permissible No. of defectives (visual and dimensional requirements) (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 100</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>101 to 300</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>301 to 500</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>501 to 1000</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

11.23.1.5 *General:*
Cellular concrete if done with precast blocks shall be laid on terrace slab after thoroughly cleaning the surface. The blocks shall be laid over a layer of 12 mm average thick cement mortar 1:4 (1 cement; 4 coarse sand) and the joints shall also be filled properly with neat cement slurry. The joints shall be staggered. Thickness of joints shall be as minimum as possible and not more than 5 mm.

11.23.1.6 *Measurements:*
Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square meter of the finished work. No deduction shall be made for openings of areas upto 0.4 Sqm. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 0.4 Sqm in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

11.23.1.7 *Rate:*
The rate shall include the cost of all materials and labour required in providing cellular concrete.

11.23.2 *With Resin Bonded Fiber Glass Wool (Bonded Mineral Wool)*

11.23.2.1 *Material:*
The material shall be mineral wool made from rock slag or glass processed from a molten state into fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall conform to specifications of group t of IS 8183.

11.23.2.2 *Dimensions:*
The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded mineral wool shall be 25, 40, 50, 65 or 75 mm.

11.23.2.3 *Tolerances:*
For width and length, the dimensional tolerances of the bonded mineral wool stabs shall be \(-\frac{1}{2}\%\). For nominal thickness in the range 25 to 75 mm the tolerance shall be \(-2\text{ mm}\). An excess, in all dimensions is permitted.

12.23.2.4 *Requirements for Fiber Glass Wool*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Characteristics</th>
<th>Group 1</th>
<th>Test Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bulk density</td>
<td>12 to 15 kg/cum</td>
<td>IS 3144</td>
</tr>
<tr>
<td>2.</td>
<td>Recovery after compression</td>
<td>not less than 90% or original thickness</td>
<td>Annex. A of IS 8183</td>
</tr>
<tr>
<td>3.</td>
<td>Shot content max</td>
<td>500 micron - 5%</td>
<td>IS 3144</td>
</tr>
<tr>
<td></td>
<td></td>
<td>250 micron-15%</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Moisture content and absorption</td>
<td>not more than 2%</td>
<td>IS 31-44</td>
</tr>
<tr>
<td>5.</td>
<td>Incumbustibility</td>
<td>Incumbustible</td>
<td>IS 3144</td>
</tr>
<tr>
<td>6.</td>
<td>Thermal conductivity deg. C at mean temperature 50 deg.C</td>
<td>0.49 mw/ cm°C</td>
<td>IS 3346</td>
</tr>
<tr>
<td>7.</td>
<td>Sulphur content</td>
<td>Not more than 0.6%</td>
<td>IS 3144</td>
</tr>
</tbody>
</table>
12.23.2.5 General:
Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling. In the second case when space above false ceiling is to be used for carrying return air 1.5" x 1.5" slotted angle (3" length) shall be fixed to the ceiling by means of rawl plugs at 2'0" spacing. Draw 14 gauge tie wires from the slots. Make a mat of mineral wool insulation backed with scrim cloth with a light coating of Plaster of Paris or polythene faced hessian and 24g x 1" wire mesh netting. The joints of wire netting should be butted and tightly laced down with G.I. wire. Stretch the mat tightly across the angles holding it in place by means of tie wires.

12.23.2.6 Measurements:
Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square meter of the finished work. No deduction shall be made for openings of areas upto 40 square decimeter. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimeter in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings. Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running meters.

12.23.2.7 Rate:
The rate shall include the cost of all materials and labour required in providing bonded mineral wool.

12.23.3 with Expanded Polystyrene
12.23.3.1 Material:
Expanded polystyrene shall conform to IS 4671. Types as given below:
(a) Type N - Normal
(b) Type SE - It shall be of self extinguishing type when tested in accordance with Appendix E of IS 4671.

12.23.3.2 Dimensions:
The size of the finished boards shall be 1.0 x 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100 mm.
(a) Tolerances.
The tolerances on length, width and thickness of the finished board shall be ±2 mm.

12.23.3.3 Requirements for Expanded Polystyrene for General Use:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Characteristics</th>
<th>Requirements at various nominal apparent densities in kg/cum</th>
<th>Test Reference</th>
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</thead>
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<td></td>
<td></td>
<td>1520 25 30 35</td>
<td>IS 3346</td>
</tr>
<tr>
<td>1.</td>
<td>Thermal conductivity (K. value) (a) at 0°C (b)at10°C</td>
<td>0.34 0.32 0.30 0.29 0.28</td>
<td>IS 4671 Appendix A</td>
</tr>
<tr>
<td>2.</td>
<td>Compressive strength at 10% deformation in Kg/sq.cm Min.</td>
<td>0.7 0.9 1.1 1.4 1.7</td>
<td>IS 4671 Appendix B</td>
</tr>
<tr>
<td>3.</td>
<td>Cross breaking strength in kg/sq. cm Min.</td>
<td>1.4 1.6 1.8 2.2</td>
<td>IS 4671 Appendix C</td>
</tr>
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<td>4.</td>
<td>Water vapour presence in g/sqm 24 hrs. Max.</td>
<td>50 40 30 20</td>
<td>IS 4671 Appendix D</td>
</tr>
<tr>
<td>5.</td>
<td>Thermal stability Percent Max.</td>
<td>1 1 1 1</td>
<td>IS 4671 Appendix E</td>
</tr>
<tr>
<td>6.</td>
<td>Water absorption</td>
<td>less than 0.5% by volume (after 24 hrs. immersion)</td>
<td>IS 4671 Appendix E</td>
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</table>
11.23.3.4 **Sampling:**
In a single consignment all the items of same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judging conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table No. 12.13 given below. The sample shall be taken at random from the lot.

<table>
<thead>
<tr>
<th>No. of items in the lot</th>
<th>No. of sample items</th>
<th>Permissible number of defective sample items</th>
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<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Upto 25</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>26 to 100</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>101 to 300</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>301 to 1000</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>1001 to 3000</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>3001 and above</td>
<td>32</td>
<td>2</td>
</tr>
</tbody>
</table>

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

11.23.3.5 **General:**
Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

11.23.3.6 **Measurements:**
Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square meter of the finished work. No deduction shall be made for openings of areas upto 40 square decimeter. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimeter in area deduction for the full opening will be made, but nothing extra will be paid for any extra material/labour involved in forming such openings.

11.24 **UNPLASTICISED POLYVINYL CHLORIDE PIPES AND FITTINGS**

11.24.1 **UPVC Pipes**
Pipes shall conform to Type a pipes of IS 13592. The internal and external surfaces of the pipes shall be smooth and clean and free from grooving and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

11.24.2 **Colour of Pipe**
Surface colour of the pipes shall be dark shade of grey or as specified.

11.24.3 **Marking**
Each pipe shall be clearly and indelibly marked with the following information's at intervals not more than 3 meter.
1. Manufacturer’s name or trade mark.
2. Nominal outside dia of pipe.
3. Type 'A'
4. Batch number.

11.24.4 **Dimensions**
(a) **Diameter and Wall Thickness:**
Mean outside diameter, outside diameter at any point and wall thickness for type -A manufactured plain or with socket shall be as given in Table-1 of IS 13592. UPVC rain water pipes shall be of the dia, specified in the description of the item and shall be in nominal lengths of 2, 3, 4 or 6 meters either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerances on specified length shall be ± 10 mm and ± 0 mm.
11.24.5 Fixing and Jointing
Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item. Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement: 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

11.24.6 Installation in Wall/Concrete
The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted into the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

11.24.7 Fittings
Fittings used shall be of the same make as that of the PVC pipes Injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socket Ted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

11.24.8 Measurements
The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. excluding all fittings along its length.

11.24.9 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing of wall plugs and PVC clips which shall be paid for separately.

Note: These pipes shall be used only in shaft or unexposed location to avoid damage to these pipes due to willful act.
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<td>Specification for paving Bitumen</td>
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<td>2.</td>
<td>IS 277</td>
<td>Galvanized steel sheets (plain and corrugated)</td>
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<td>3.</td>
<td>IS 651</td>
<td>Glazed stoneware pipes and fittings</td>
</tr>
<tr>
<td>4.</td>
<td>IS 702</td>
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<td>7.</td>
<td>IS 1200(PTX)</td>
<td>Method of measurements of building and civil engineering works: Part-10 ceiling and lining</td>
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<td>Cast iron rain water pipes and fitting</td>
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<td>Technical supply conditions for threaded steel fasteners pt.13 hot dip galvanized coating on threaded fasteners</td>
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<td>Gypsum plaster boards (Pt.1) plain Gypsum plaster boards</td>
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<td>IS 2115</td>
<td>Code of practice for flat roof finish; mud phuska</td>
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<td>12.</td>
<td>IS 2633</td>
<td>Method of testing uniformity of coating on zinc coated articles</td>
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<td>13.</td>
<td>IS 2645</td>
<td>Specification for integral water proofing compounds for cement mortar and concrete</td>
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<td>Specification for rubber sealing rings for gas mains, water mains and sewers</td>
</tr>
<tr>
<td>23.</td>
<td>IS 5688</td>
<td>Methods of test of performed block type and pipe covering type thermal insulations</td>
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<td>24.</td>
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<td>Cellular concrete for thermal insulation</td>
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12.00 FINISHING
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12.0 FINISHING
12.1 CEMENT PLASTER
On masonry work it is a layer of a mix consist of cement, sand & water. Plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

12.1.1 Scaffolding for Plaster work:-
For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The support shall be sound strong, tied together with horizontal pieces over which scaffolding planks shall be fixed it shall be provided to allow easy approach to every part of the work.

Single scaffolding shall be permitted for all other work in buildings. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one meter in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

Note: In case of special type of brick work, scaffolding shall be got approved from Engineer-in-charge in advance.

12.1.2 Preparation of Surface
a) The joints of masonry work shall be raked out and loose mortar shall be removed by brushed. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plaster.

b) In case of concrete work if a chemical retarder has been applied to the form work, the surface of concrete work shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that complete chemical retarder has been removed from the concrete surface.

12.1.3 Mortar
The mortar of the specified mix shall be used. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used. Grading of fine aggregate have been discussed in chapter 2 of specification.

12.1.4 Application of Plaster
The plaster on ceiling shall be completed before commencement of plaster on walls. The plastering work shall be started from the top and worked down towards the floor. The scaffolding is being taken down and all putlog holes shall be properly filled before the plastering. To ensure even thickness, the plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2 meters intervals over the entire surface to serve as gauge. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the surface, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and side ways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troubleshooting or over working the float shall be avoided.

All the corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, provision of grooves at junctions etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

At the end of the day while suspending the plaster work, the plaster shall be left, cut clean to line both horizontally and vertically. When restarting the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Horizontal Joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar. Any portion of the surface shall not be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water...
to the dry mortar.

12.1.5 Thickness
Where the thickness required as per description of the item is 20 mm the average thickness of the plaster on walls shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

12.1.6 Finish
The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

12.1.7 Curing
Curing shall be started as soon as the plaster has hardened sufficiently. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve.

12.1.8 Precaution
Cracks in plaster are hallow part of plaster are defective part of plaster shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

(a) When plaster on ceiling is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6 mm drawn with any suitable method with the wall while the plaster is green.

(b) To prevent surface cracks appearing between junctions of column or beam and walls, 15 cm wide chicken wire mesh should be fixed with U nails 15 cm centre to centre before plastering the junction. The plastering of walls and beam or column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails & payment shall be made separately.

12.1.9 Measurements
Length and breadth shall be measured correct to a cm and its area shall be calculated in square meters correct to two places of decimal. Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick work. The measurement of wall plaster shall be taken between the walls or partitions (the dimensions before the plaster shall be taken) for the length and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.

12.1.9.1 The following shall be measured separately from wall plaster.
(i) Plaster bands 30 cm wide and under
(ii) Cornice headings and architraves or architraves moulded wholly in plaster.
(iii) Circular work not exceeding 6 m in radius.
(iv) Plaster over masonry pilasters will be measured and paid for as plaster only. A coefficient of 1.63 shall be adopted for the measurement of one side plastering on honey comb work having 6x10 cm. opening.

12.1.9.2 Moulded cornices and coves.
(i) Length shall be measured at the centre of the girth.
(ii) Moulded cornices shall be given in square meters the area being arrived at by multiplying length by the girth.
(iii) Flat or weathered top to cornices when exceeding 15 cm in width shall not be included in the girth but measured with the general plaster work.
(iv) Cornices which are curved in their length shall be measured separately.

12.1.9.3 Exterior plastering at a height more than 10 m from average ground level shall be measured separately in each storey height. Patch plastering (in repairs) shall be measured as plastering new work, where the patch exceed 2.5 sqm. Extra payment being made for preparing old wall, such as dismantling old plaster, raking out the joints and cleaning the surface. Where the patch does not exceed 2.5 sqm in area it shall be measured under the appropriate item under sub head 'Repairs to Buildings.'
12.1.9.4 For opening etc the deductions in measurements, will be as follows:-

(i) Deduction shall not be made for openings or ends of joists, beams, posts, girders, steps etc. upto 0.5 sqm in area and no additions shall be made either, for the jambs, soffits and sills of such openings, to both the faces of wall.

(ii) Deduction for opening exceeding 0.5 sqm but not exceeding 3 sqm each shall be made for reveals, Jambs, soffits, sills, & sills, etc. of these openings.

(ii-a) When both faces of walls are plastered with same plaster, deductions shall be made for one face only.

(ii-b) When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed or one face is plastered and other is un-plastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which width of reveals is less than that on the other side but no deduction shall be made on the other side. Where width of reveals on both faces of wall is equal, deduction of 50% of area of opening on each face shall be made from area of plaster or pointing as the case may be.

(ii-c) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

(iii) For opening exceeding 3 sqm in area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment.

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

12.1.10 Rate
The rate shall include the cost of all labour and materials involved in all the operations described as above.

12.2 CEMENT PLASTER WITH A FLOATING COAT OF NEAT CEMENT
12.2.1 Specifications for this item of work shall be same as described in para 12.1 except for the additional

Floating coat which shall be carried out as below:-
When the plaster has been brought to a true surface with the wooden straight edge it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be @ 1 kg/sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications given in 12, 1.4 shall apply.

12.3 18MM CEMENT PLASTER (TWO COAT WORK)
The specification for scaffolding and preparation of surface shall be as described in 12.1.1 & 12.1.2.

12.3.1 Mortar
The mix and type of fine aggregate specified in the description of the item shall be used for the respective coats. Generally the mix of the under coat shall be richer than the finishing coat unless otherwise described in item.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat, unless otherwise specified. For external work and under coat work, the fine aggregate shall conform to grading zone IV and for finishing coat work the fine aggregate conforming to grading zone V shall be used.

12.3.2 Application
The plaster shall be done in two coats i.e. 12 mm under coat and then 6 mm finishing coat and shall have an average total thickness of not less than 18 mm.

(a) 12 mm Under Coat: This shall be done as specified in 12.1.4 except that when the plaster has been brought to a true surface by a wooden straight edge, the surface shall be left rough and furrowed
2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

(b) 6 mm Finishing Coat: The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified in 12.1.4.

12.3.3 The specifications for Finishing, Curing, Precautions, Measurements and Rate shall be as described in para 12.1.6 to 12.1.10.

12.4 6MM CEMENT PLASTER ON CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK

12.4.1 Scaffolding
Stage scaffolding shall be provided for the work. This shall be independent of the walls.

12.4.2 Preparation of Surface for plaster:-
Extra mortar deposit or any projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed and the surface shall be scrubbed clean with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacing’s of not more than 5 cm. Centre, the pock being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

12.4.3 Mortars
Mortar of the specified mix using the types of sand described in the item shall be used. It shall be as specified in 12.2.

12.4.4 Application of Plaster
To ensure even thickness and a true surface, gauges of plaster 0.15m x 0.15 m. shall be first applied at not more than 1.5 m intervals in both the directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess trowelling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In the case of ceiling of roof slabs, plaster shall not be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

12.4.5 Finishing
The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work precedes with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

12.4.6 Curing & Precautions
The specifications shall be as specified in para 12.1.7 and 12.1.8

12.4.7 Measurements
12.4.7.1 Dimensions before plastering shall be taken. Length and breadth shall be measured correct a cm. and its area shall be calculated in sqm. Correct to two places of decimal. Thickness of plaster shall be exclusive of the thickness of the key i.e. depth or rock marks and hacking. Plastering on ceiling at height greater than 5 m above the corresponding floor level shall be so described and shall be measured separately stating the height in stages of 1 m or part thereof.

Plastering on the sides and soffits of the projected beams of ceiling at a height greater than 5 m above
the corresponding floor level shall be measured and added to the quantity measured as above. Plastering on spherical and groined ceiling and circular work not exceeding 6 m in radius, shall be measured and paid for separately. Flowing sophist (viz. portion under spiral stair case etc.) shall be measured and paid for separately. Ribs and moulding on ceiling shall be measured as for cornices; deductions being made from the plastering on ceiling in case the width of the moulding exceed 15 cm.

12.4.9.2 The mode of measurement of exterior plastering and patch plastering (in repairs) shall be as laid down in 12.1.9.3

12.1.9.3. Deduction shall not be made for openings or for ends of columns, or columns caps of 0.5 sqm each in area and under. No additions will be made either for the plastering of the sides of such openings. For openings etc. of areas exceeding 0.5 sqm deduction will be made for the full opening but the sides of such openings shall be measured for payment.

12.4.10 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.

12.5 6MM CEMENT PLASTER FOR SLAB BEARING
Cement plaster shall be 6 mm thick finished with a floating coat of neat cement and thick coat of lime wash on top of walls for bearing of slabs.

12.5.1 Application
The plaster shall be applied over the cleaned and wetted surface of the wall. When the plaster has been brought to a true surface with the wooden straight edge. Surface shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth; so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be @ 1 kg/sqm. Smooth finishing shall be completed with trowel immediately and in no case later than 30 minute of adding water to the plaster mix. The specification given para 12.1.4 shall also applicable.

12.5.2 Lime wash
Lime wash shall be applied in a thick coat after curing the plaster for three days.

12.5.3 Measurements
Length and breadth shall be measured correct to a cm and area worked out in sqm correct to two places of decimal.

12.5.4 Rate
The rate shall include the cost of all labour and materials involved in all the operations described as above.

12.6 NEAT CEMENT PUNNING
12.6.1 The specifications given for floating coat described in 12.2.1 shall apply.

12.6.2 Specification for scaffolding and curing shall be as described in 12.1.1 and 12.1.7. Respectively. Specifications for Finish and Precautions shall be as described in 12.1.6. And 12.1.8.

12.6.3 Measurement:- The measurement shall be taken by procedure given bellow
(1) The measurements for cement punning shall be taken over the finished work. The length and breadth shall be measured correct to a cm.
(2) The area shall be calculated in sqm correct to two places of decimal.
(3) Punning over Plaster on bands, skirting, coping, cornices, drip courses, string courses etc. shall not be measured separately but only as wall surfaces.
(4) In these cases the measurements shall be taken girthed over the above features.
(5) Punning over plaster on circular work also, of any radius shall be measured only as wall surfaces, and not separately.
(6) Cement punning in patch repairs irrespective of the size of the patch shall be measured as new work, and in this case the rate shall include for cutting the patch to rectangular shape before time punning. Deductions in measurements for openings shall be regulated generally as described in para 12.1.9.4.
12.6.4 Rate shall include the cost of all labour and materials involved in all the operations described as above.

12.7 ROUGH CAST PLASTER
The Rough cast finish comprises of a mixture of sand and gravel in specified proportions dashed over a freshly plastered surface.

12.7.1 Scaffolding
Scaffolding shall be done as specified in para 12.1.1.

12.7.2 Preparation of Surface
The joints shall be raked out, dust and loose mortar, shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

12.7.3 Mortar
Mortar of specified mix using the type of sand described in the item shall be used, where coarse sand is to be used, the fineness modulus of the sand shall not be less than 2.5 mm.

12.7.4 Application
12.7.4.1 The plaster base over which rough cast finish is to be applied shall consist of two coats, under layer 12 mm thick and top layer 10 mm.

(a) **12mm Under Layer**: This shall be applied in the same manner as specified in para 12.1.3 under 12mm cement plaster except that the finishing, after the mortar has been brought to a level, with the wooden straight edge, shall be done with wooden float only.

(b) **Top Layer**: The top layer shall be applied a day or two after the under layer has taken initial set. The tatter shall not be allowed to dry out, before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of rich mix 1:3 (1cement: 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well pitched with the plaster surface. In order to make the base plastic, about 10% of finely grouted hydrated lime by volume of cement, shall be added when preparing mortar for the top layer.

12.7.5 Finish
It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 2.36 mm to 12.5 mm or as specified and in the proportions as specified accurately to the effect required. The mixture shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix gets well pitched into the plaster base. The mix shall again be dashed over the vacant spaces if any so that the surface represents homogeneous surfaces of sand mixed with gravel. A sample of rough cast plaster shall be got approved by the Engineer-in-Charge.

12.7.6 Specification for precautions, measurement and rate shall be as described under para 12.1.8 to 12.1.10.

12.8 PEBBLE DASH FINISH (IN SITU WORK)
The specification shall be the same as for rough cast plaster, except that the washed pebbles or crushed stone graded from 12.5 mm to 6.3 mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified by hand, so that the finished surface represents a homogeneous surface.

Specification for scaffolding, preparation of surface, Mortar, Measurements and Rate shall be as described under para 12.1.1 to 12.1.10.

12.9 PLAIN BANDS OF CEMENT MORTAR
It is a plaster strip of uniform width not exceeding 30 cm and of uniform thickness, provided for decorative or other purpose flush with, sunk below or projecting beyond, the wall plaster. A flush band is one where due to the difference in mix or shade of the mortar, the band is executed as a separate and distinct operation from the wall plaster. The thickness of a raised band is the thickness of the projection beyond the plane of the wall plaster. In the case of a flush or a sunken band, the thickness
will be the thickness of the plaster measured from the untreated wall surface.

12.9.1 Preparation of Surfaces and Application
(a) In the case of flush or sunk bands the Joints shall be raked out properly then dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing the scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

(b) For preparation of concrete surface the specification given in para 12.1.2(b) shall be applicable

(c) In case of raised band, the surface shall be prepared as specified in 12.1.4. The surface of the wall plaster behind the band shall be left rough and furrowed 2 mm deep with a scratching tool, diagonally both ways to form key for the band. No reduction in the rate for the above backing wall plaster shall, however, be made for not finishing the same smooth.

12.9.2 Mortar
Mortar of the mix and type of sand as specified in the description of the item shall be used.

12.9.3 Finish of Plain bands of cement mortar
These shall be finished exactly to the size as shown in the approved drawings. The horizontal or vertical lines of bands shall be truly parallel and straight and the surfaces shall be finished truly plane and smooth. The lines and surfaces shall be checked with fine threads for straightness, level and accuracy.

12.9.4 Scaffolding, Curing and Precaution shall be as described under para 12.1. To 12.1.7 & 8

12.9.5 Measurements
Length will be measured in running meters correct to a cm. The length shall be taken along the finished face. The width shall not be measured by girth. For width of band 30 cm or below, the width shall be measured in cm correct to 5 mm. The quantity shall be calculated in meter-cm units.

12.9.6 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above. Nothing extra shall be paid for mitered stops nor for bands on curved surfaces of whatever radius, may they be. The rate is also inclusive of all rounding or chamfering at corners, arises, providing grooves at junctions etc.

12.10 MOULDED BANDS OF CEMENT MORTAR (SINGLE COAT WORK)
It is a plaster strip of uniform width but with varying thickness across its section formed over wall plaster for decorative purposes. The sectional periphery of the band is formed by a combination of straight lines or of curved lines or of straight lines and curves.

12.10.1 Preparation of Surface, Mortar, Scaffolding, Curing and Precautions shall be as specified under para 12.9.

12.10.2 Thickness
The higher thickness stipulated in the description of the item shall refer to the upper limiting thickness of the moulding at its most projected portion, measured from the wall plaster.

12.10.3 Application and Finish
Proper templates conforming accurately to the sectional periphery of the moulded band shall be got approved, before use. The finished band shall be true to the template at all sections. The lines of the band shall be truly parallel and straight and surfaces smoothly finished.

12.10.4 Measurements
The width of the band 30 cm or below shall be measured in cm correct to 5 mm and shall be measured along the sectional periphery of the moulded band, from wall plaster face to wall plaster face. The length shall be measured, in running meters correct to a cm. It shall be taken along the finished face of the band at the centre of its girth. The quantity should be calculated in meter-cm units.

12.10.5 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above. Nothing extra shall be paid for miter, stops nor for bands on curved surfaces of whatever radius, may they be. The rate is also inclusive of all rounding or chamfering at corners, arises etc.

12.11 MOULDED BANDS OF CEMENT MORTAR (TWO COAT WORK)
It is a plaster strip of uniform width but with varying thickness across its section formed over wall plaster for decorative purposes. The sectional periphery of the band is formed by a combination of straight lines or of curves or of straight lines and curves.

12.11.1 Thickness
The higher thickness stipulated for the under coat in the description of the item shall refer to the upper limiting thickness of the under coat of the moulding at its most projected portion from the wall plaster. The thickness stipulated for the finishing coat is the uniform thickness of the finished peripheral surface of the moulded band from the under coat.

12.11.2 Mortar
The under coat shall consist of cement mortar 1:5 (1 cement: 5 coarse sand) and the top coat shall be of cement mortar 1:4(1 cement: 4 fine sand) unless otherwise specified in the description of item.

12.11.3 Application and Finish
Proper templates conforming to the sectional periphery of the moulded band as at the stages of under coat and the finished final coat shall be made and got approved and used at the proper stages in executing the bands to true and accurate profile. The lines of the bands as finally completed shall be truly parallel and straight and the surfaces smoothly finished.

12.11.4 All other specifications shall be as specified under in para 12.10.

12.12 CEMENT WATER PROOFING COMPOUND
It shall be used for cement mortar for plastering or concrete work.

The integral cement water proofing compound conforming to IS 2645 and of other water proofing compound, enlisted by the Engineer-in-Charge from time to time shall be used for cement mortar for plastering of concrete work.

The contractor shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added.

It shall be measured by weight and rate shall include the cost of all labour and materials involved in all the operations described above.

12.13 POINTING ON BRICK WORK, TILE WORK AND STONE WORK :- Following type of pointing shall be used in brick work, tile work and stone work
1) Flush pointing
2) Raised and cut pointing
3) Struck and weathered pointing
4) Ruled pointing

Pointing shall be of the type shown in figure below:
12.13.1 Scaffolding
As specified in para 12.1.1

12.13.2 Preparation of surface
The Joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunken surface of the finished pointing or from the edge of the brick shall not be less than 12 mm. The specification shall be as para 12.1.2.

12.13.3 Mortar
Mortar of specified mix shall be used. It shall be as specified under Chapter 2.0.

12.13.4 Application and Finishing
The mortar shall be pressed into the raked out Joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool, in the manner described below:-

(a) **Flush Pointing**: The mortar shall be pressed into the raked joints and shall be finished off flush and level with the edges of the bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

(b) **Ruled Pointing**: The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

(c) **Cut or Weather Struck Pointing**: The mortar shall first be pressed into the joints. The top of the horizontal joints shall then be neatly pressed back about 3 mm or as directed, with the pointing tool so that the joints are sloping from top to bottom. The vertical joints shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

(d) **Raised and Cut Pointing**: Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm raised and width 10 mm more as directed.

12.13.4 Precaution
12.13.4.1 The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape required and the edges are straight, neat and clean.

12.13.4.2 The pointing lines shall be truly horizontal and vertical except where the joints are slanting as in rubble random masonry. Lines of joints from different directions should meet neatly at the Junctions instead of crossing beyond.

12.13.5 Curing
The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages.

12.13.6 Measurements
The various types of pointing, struck, keyed, flush, tuck, etc. shall each be measured separately. Pointing on different types of walls, floors, roofs etc. shall each be measured separately. The type and material of the surface to be pointed shall be described.

Length and breadth shall be measured correct to a cm and its area shall be calculated in square meters upto two places of decimal. Pointing in a single detached Joint as for flashing shall be given in running meters.
12.13.6.1 Deduction and addition in measurement for Pointing on external face:-

For Jambs, soffits, sills etc. for opening not exceeding 0.5 sqm each in area, ends of joists, beams, posts, girders, steps etc. not exceeding 0.5 sqm each in area and opening not exceeding 3 sqm each deductions and additions shall be made in the following way:-

(a) Deduction shall be done for ends of joists, beams, posts etc. and openings not exceeding 0.5 sqm each, and addition shall not be made for reveals, Jambs, soffits, sill, etc. of these openings.

(b) Deductions for openings exceeding 0.5 sqm but not exceeding 3 sqm each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills, etc. for these openings.

(c) When both the faces of the wall are pointed with the same pointing deduction shall be made for one face only.

(d) When two faces of wall are pointed with different pointing or if one face is plastered and other is pointed or plastered, deduction shall be made from the plaster or pointing on the side of frames for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.

(e) Where width of reveals on both faces of wall is equal deduction of 50% of area of opening on each face shall be made from area of pointing or plaster as the case may be.

(f) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.

12.13.6.2 In case of openings of area above 3 sqm each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured. The following shall be measured separately.

(I) Raking out joints for old work only shall be measured and given in square meters.

(ii) Raking out joints of old work built in mud mortar, lime mortar and cement mortar shall each be measured separately.

(iii) Raking out joints of different types of old walls, floors etc. shall each be measured separately.

(iv) Raking single detached joints as for flashing old work shall be given in running meters.

12.13.7 Rate
The rate shall include the cost of all materials and labour involved in all the operations described above.

12.14 WHITE WASHING WITH LIME
12.14.1 Scaffolding
When scaffolding is necessary for white washing it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed. Double scaffolding having two sets of vertical supports shall be provided for all exposed brick work or tile work. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls, for white washing the ceiling, proper stage scaffolding shall be erected.

12.14.2 Preparation of Surface
(a) When of new work is white washed; the surface shall be thoroughly brushed free from mortar droppings and foreign matter.

(b) In case of old work, all loose particles and scales shall be scrapped off and holes in plaster as well as patches of less than 50 sqcm area shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer-in-Charge, the entire surface of old white wash shall be thoroughly removed by scraping and this shall be paid for separately. Where efflorescence is observed the
deposits may be brushed clean and washed. The surface shall then be allowed to dry for at least 48 hours before white washing is done.

12.14.3 Preparation of Lime Wash
The lime wash shall be prepared from fresh stone white lime of katani or satana. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 0.01 cubic meter of the cream. The approximate quantity of water to be added in making the cream will be 5 liters of water to one kg of lime. Neel @ 3 gm/kg of lime dissolved in water shall then be added and stirred well. Water shall then be added @ 5 liter/kg. Of lime to produce a milky solution.

12.14.4 Application
The white wash shall be applied with moonj brushes to the required number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries. Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Eng-in-Charge before the subsequent coat is applied. Any part of the surface shall not be left initially to be patched up later on.

(a) For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. There shall be no singe of cracking and peeling on finished and dry surface. Lime shall nor come off readily on the hand when rubbed.

(b) For old work, after the surface has been prepared as described in para 12.14.2 a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as required in the above shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patches do not appear. The washing on ceiling should be done prior to that on walls.

Note: In case of Hessian ceiling, on no account, lime shall be used as it rots cloth and hessian.

12.14.5 Protection work against splashing and dropping:-
The doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed and the surfaces cleaned by the contractor at his own cost. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

12.14.6 Measurements
Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals. For Jambs, Soffits and sills etc. method of measurement shall be as described in para 12.1.9.

12.14.6.1 Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area:-
(a) Corrugated non-asbestos cement sheet 20%
(b) Semi corrugated non-asbestos cement sheet 10%

Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements. The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared. Work on old treated surfaces shall be measured separately and so described.

12.14.7 Rate
The rate shall include all material and labour involved in all the operations described above.

12.15 SATNA / KATNI LIME WASHING
Satna/Katni lime wash shall be used as a base coat or where so specified. All specifications as
described in para 12.14 shall be apply.

12.16 WHITE WASHING WITH WHITING
For Whiting white chalk shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form thin slurry which shall then be screened through a clean course cloth. Two kg of gum and 0.4 kg of copper Sulphates dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for whiting work. Other specifications described as in para 12.14 shall apply.

12.17 COLOUR WASHING
The mineral colours, not affected by lime, shall be added to white wash. Neel shall not be used for making colours wash however, not be added. No colour wash shall be done until a sample of the colour wash of the required shade has been got approved by the Engineer-in-Charge. The colour shall be of even over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.
(a) On new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats shall then be applied on the entire surface till it represents a smooth and uniform finish.
(b) On old work, after the surface has been prepared as described in 12.14.2 a coat of colour wash shall be applied over the patches and repairs. Then a single coat or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface to give a uniform finish. The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.
Other specifications as described under para 12.14. shall apply

12.18 DRYDISTEMPERING
Dry distemper of required colour as per IS 427 of approved brand manufacture by the engineer in charge shall be used. The dry distemper colour as required shall be stirred slowly in clean water using 0.6 liter of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency. Distemper shall not be mixed in larger quantity than is actually required for one day's work.

12.18.1 Preparation of Surface
(a) In case of new work, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth. New plastered surfaces shall be allowed to dry completely, before applying, distemper.
(b) In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc. Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

12.18.2 Priming Coat
A priming coat of whiting as per 12.16 shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. White washing coat shall not be used as a priming coat for distemper. The treated surface is allowed to dry before distemper coat is given.

12.18.3 Application
(a) In the case of new work, the treatment shall consist of a priming coat of whiting as per para 12.16 followed by the application of two or more coats of distemper till the surface shows an even colour.
(b) In case of old work, the surface prepared as described in para 12.14. shall be applied one or more coats of distemper till the surface attains an even colour.

The application of each coat shall be as follows:-
i) The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.
ii) The subsequent coats shall be applied only after the previous coat has dried.
iii) The finished surface shall be even and uniform and shall show no brush marks.

12.18.3.1 Precautions:-
A) Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

B) After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes which are dirty or caked with distemper shall not be used.

12.18.4 All other specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under para 12.14.

12.19 OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING

12.19.1 Materials
Oil emulsion (Oil Bound) washable distemper as per IS 428 of approved brand and manufacture approved by engineer in charge or as specified in item shall be used. The primers where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed container in sufficient quantities at a time to complete the work of a fortnight's work, The empty containers shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer in Charge.

12.19.2 Preparation of the Surface
(a) In case of new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

(b) For old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of Paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

12.19.3 Application
12.19.3.1 Priming Coat: The priming coat shall be with distemper primer or cement primer, as required in the description of the item and the application shall be as described in para 12.14.4

Oil bound distemper shall not to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat of alkali, resistant priming Paint conforming to IS 109 and allowed to dry for at least 48 hours before distempering is commenced. In case of old work no primer coat is necessary.

12.19.3.2 Distemper Coat: In case of new work, after the primer coat has dried for at least 48 hours, the surface shall be sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coats shall be applied, in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval shall be at least 24 hours between successive coats to permit proper drying of the preceding coat.
In the case of old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

12.19.4 All other specifications in respect of scaffolding, protective measures and measurements shall be as described under para 12.14.

12.19.5 The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

12.20 CEMENT PRIMER COAT
The Cement primer coat is used as a base coat on wall finish of cement, plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is resistant to the alkalies present in the cement, in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints. Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with dement primer before applying oil emulsion Paints etc.

12.20.1 Preparation of the Surface
The surface shall be thoroughly cleaned of dust, old wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, on the entire surface including filling up the undulations and then sand papering the same after it is dry. Putty shall be made with plaster of paris mixed with water.

12.20.2 Application
The cement primer shall be applied with a brush on the dry smooth, and clean surface. Horizontal strokes shall be given, first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks and shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

12.20.3 All other Specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under para 12.1.4.

12.21 CEMENT PAINT
12.21.1 Material
The cement Paint shall be as per to IS 5410. It shall be of approved brand and manufacture. It shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in sufficient quantities to suffice for the whole work or at least a fortnight's work. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed.

12.21.2 Preparation of Surface
In case of new Work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement Paint shall be applied over patches after wetting them thoroughly.

12.21.3 Preparation of Mix
It shall be mixed in such quantities as can be used up within one hour of its mixing. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer’s instructions shall be followed. The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities.

In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be
consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

12.21.4 Application

The applications shall be as given below:-

(a) The solution shall be applied on the clean and wetted surface with brushes or spraying machine as per method recommend by manufacture. The solution shall be kept wet Stirred during the period of application and shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The completed surface shall be watered after the day’s work.

(b) The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

(c) In case of new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

(d) In case of old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

12.21.5 Precaution

The Water proof cement Paint shall not be used on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc and shall not be applied on gypsams, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

12.21.6 All specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under para 12.14.

12.22 EXTERIOR PAINTING ON WALL

12.22.1 Material

The paint shall be of approved brand and manufacture such as textured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight’s work. The empty containers shall not be removed from the site of work till the relevant item of work has been completed.

12.22.2 Preparation of Surface

In case of new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, fungus or moth, grease and other foreign matter by brushing and washing, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

12.22.3 Application

All specifications in respect of base coat of water proofing cement paint shall be same as described under para 12.21. Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer’s instructions & directions of the Engineer-in-charge shall be followed meticulously. The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

12.22.4 All specifications in respect of scaffolding, protective measures, measurements and rate shall
be as described under para 12.14.

12.23 PAINTING to wood work and steel work

12.23.1 Materials
Ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used. If it is required to dilute the ready mixed paint than the branded thinner shall be used as per permission of the engineer-in-charge Approved Paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in sufficient quantities to full fill the requirement of for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed.

12.23.2 Preparation of Surface
The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

12.23.3 Application
The applications shall be as follows:-
(a) Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also; the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

(b) The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over with Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

(c) Where so stipulated, the painting shall be done by spraying by Spray machine as approved by the Engineer in charge Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

(d) Spraying should be done only in dry condition. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied, this should be facilitated by thorough ventilation. Each coat except the last coat shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

(e) No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

(f) No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

(g) During painting doors and windows, the putty round the glass panels must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need not be done and any deduction on this account will not be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

(h) On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

12.23.4 Brushes and Containers
The brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine after closing the work of a day. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use shall be kept closed and free from air so that Paint does not thicken and also shall be kept safe from dust.
12.23.5 Measurements
The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated. Small articles not exceeding 0.1 sqm of painted surfaces where not in conjunction with similar painted work shall be enumerated. Painting upto 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running meters and shall include cutting to line where so required.

12.23.5.1 In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Table - 1
Equivalent Plain Areas of Uneven Surface

<table>
<thead>
<tr>
<th>S.</th>
<th>Description of work</th>
<th>How measured</th>
<th>Multiplying coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wood work doors, windows Etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Panelled or framed and braced Doors, windows etc.</td>
<td>Measured flat (not girthed)</td>
<td>1.30 (for each side)</td>
</tr>
<tr>
<td></td>
<td>2. Ledged and batten ed or ledged, batten ed and braced</td>
<td>Chowkhat s or frame, Edges, cleats, etc. shall be</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>doors, Windows etc.</td>
<td>deemed to included in the item.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Flush doors etc.</td>
<td>-do-</td>
<td>1.20 (for each side)</td>
</tr>
<tr>
<td>4</td>
<td>Part paneled and part glazed or gauzed doors, window</td>
<td>-do-</td>
<td>1.00 (for each side)</td>
</tr>
<tr>
<td></td>
<td>etc. : (Excluding painting of wire gauze portion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Fully gazed or gauzed doors, windows etc. (Excluding</td>
<td>-do-</td>
<td>0.80 (for each side)</td>
</tr>
<tr>
<td></td>
<td>painting of wire gauze portion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Fully venation or louvered</td>
<td>-do-</td>
<td>1.80 (for each side)</td>
</tr>
<tr>
<td></td>
<td>Doors, windows etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trellis (or Jaffri) work one way or</td>
<td>Measured flat overall, no shall be made for open</td>
<td>2 (for painting all over)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spaces, porting members shall not be surfed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>separately</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Carved or enriched work</td>
<td>Measured flat</td>
<td>2 (for each side)</td>
</tr>
<tr>
<td>9</td>
<td>Weather boarding</td>
<td>Measured flat (not girthed)</td>
<td>1.20 (for each side)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>frame work shall not be separated</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Wood shingle roofing</td>
<td>Measured flat (not girthed)</td>
<td>1.10 (for each side)</td>
</tr>
<tr>
<td>11</td>
<td>Boarding with cover fillets and match boarding</td>
<td>Measured flat (not girthed)</td>
<td>1.05 (for each side)</td>
</tr>
<tr>
<td>12</td>
<td>Tile and slate battening</td>
<td>Measured flat overall no shall be made for open</td>
<td>0.80 (for painting all</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spaces</td>
<td>over)</td>
</tr>
</tbody>
</table>

II. Steel work doors, windows Etc.

<table>
<thead>
<tr>
<th>S.</th>
<th>Description of work</th>
<th>How measured</th>
<th>Multiplying coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plain sheeted steel doors or Windows</td>
<td>Measured flat (not girthed)</td>
<td>1.10 (for each side)</td>
</tr>
<tr>
<td>2</td>
<td>Fully glazed or gauzed steel doors and windows (excluding painting of wire gauze portion)</td>
<td>-do-</td>
<td>0.50 (for each side)</td>
</tr>
<tr>
<td>3</td>
<td>Partly Panelled and partly glazed or gauzed doors and</td>
<td>-do-</td>
<td>0.80 (for each side)</td>
</tr>
<tr>
<td></td>
<td>windows (excluding painting of wire gauze portion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Corrugated sheeted steel doors or windows</td>
<td>-do-</td>
<td>1.25 (for each side)</td>
</tr>
<tr>
<td>5. Collapsible gates</td>
<td>Measured flat</td>
<td>1.50 (for painting all over)</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>6. Rolling shutters of interlocked Laths</td>
<td>Measured flat (size of opening) over; jamb guides, bottom rails locking arrangement etc. shall be measured separately</td>
<td>1.10 (for each side)</td>
<td></td>
</tr>
</tbody>
</table>

### III. General

1. Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in Windows frames. Measured flat overall; no shall be made for open spaces; supporting members shall not be measured separately 1 (for Paint all over)

2. Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel -do- (see note No. 12) 1 (for Paint all over)

3. Corrugated iron sheeting in Roofs, side cladding etc. -do- Measured flat (not girthed) 1.14 (for each side)

4. AC corrugated sheeting in roofs, Side cladding etc. -do- 1.20 (for each side)

5. AC semi corrugated sheeting in roofs, side cladding etc. or Neonatal pattern using plain sheets -do- 1.10 (for each side)

6. Wire gauze shutters including painting of wire gauze -do- 1.00 (for each side)

### Explanatory Notes for Table 1

(a) Measurements for doors windows etc., shall be taken flat (and not girthed) over all including Chowkhat or frames, where provided. Where Chowkhat or frames are not provided, the shutter measurements shall be taken.

(b) Where doors, windows etc., are of composite types other than those included in Table as above the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.

(c) The coefficients for door and windows shall apply irrespective of the size of frames and shutter members.

(d) In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.

(e) When the two faces of a door, window etc. are to be treated with different specified finishes measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

(f) In the case where shutters are fixed on both faces of the frames, the measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.

(g) Where shutters are provided with clearance at top or/bottom each exceeding 15 cm height, such openings shall be deducted from the over all measurements and relevant coefficient shall be applied to obtain the area payable.

(h) Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
(i) Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, roller, fittings etc.

(j) Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

(k) The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

(l) For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades.

12.23.5.2 Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sq. meter and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work. Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running meters of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc. Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual. Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

12.23.6 Precautions
All furniture's, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damages done shall be made good by the contractor at his cost.

12.23.7 Rate
Rates shall include cost of all labour and materials involved in all the operations described above.

12.24 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES
12.24.1 Primer.
The primer for plaster/wood work/Iron & Steel/Aluminum surfaces shall be as specified in the description of the item and shall be as below:

<table>
<thead>
<tr>
<th>SNo’s.</th>
<th>Surface</th>
<th>Primer to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wood work (hard and soft wood)</td>
<td>Pink conforming to IS 3536</td>
</tr>
<tr>
<td>2</td>
<td>Resinous wood and plywood</td>
<td>Aluminum primer conforming to IS 3585</td>
</tr>
<tr>
<td>3</td>
<td>A) Aluminum and light alloys</td>
<td>Zinc chromate primer conforming to IS 104</td>
</tr>
<tr>
<td></td>
<td>B) Iron, /RCC/brick work, Plastered surfaces, non-asbestos</td>
<td>Primer conforming IS 2074</td>
</tr>
<tr>
<td></td>
<td>surfaces to receive Oil bound distemper or Paint finish.</td>
<td>Red Oxide Zinc chromate</td>
</tr>
<tr>
<td>4</td>
<td>Cement/Conc./RCC/brick work, Plastered surfaces, non-</td>
<td>Cement primer conforming to IS 109</td>
</tr>
</tbody>
</table>
The primer shall be ready mixed primer of approved brand and manufacture. Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 liter. Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg : 1 liter : 1 liter.

The White lead shall be pure free from adulterants like barium Sulphates and whiting and shall be conform to IS 103. Red lead shall be in powder form and shall be pure and free from adulterants like brick dust etc and shall conform to IS 102. Raw linseed oil shall be lightly viscous but clear and of yellowish colour with light brown tinge, its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928. Double Boiled Linseed Oil shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30° C. It shall dry with a glossy surface. It shall conform in all respects to IS 77 and oil shall be of approved brand and manufacture. Turpentine: Mineral turpentine is a petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall conform to IS 533.

12.24.2 Preparation of Surface
(a) Wooden Surface: The wood work to be painted shall be dry and free from moisture. All unevenness surfaces shall be rubbed down smooth with sand paper and shall be well dusted and cleaned. The surface treated for knotting shall be dry before Paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier’s putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

(b) Iron & Steel Surface: All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken applying priming code.

(c) Plastered Surface: The complete dry surface shall be painted. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand before primer is applied holes and undulations, shall be filled up with plaster of Paris and rubbed smooth.

12.24.3 Application
The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described in para 12.22.3.

12.24.4 All other specifications described under para 12.23.3 shall applicable.

12.25 PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS
Synthetic enamel The paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S. sheets shall be painted with a priming coat of one coat of red oxide zinc chromate Paint. Primer shall be applied before fixing sheets in place.

12.25.1 Preparation of Surface
(a) Painting New Surface: gnarly new G.I sheet shall not be painted, painting on new G.I sheet shall be done when the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a liter of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a liter of soft water. This quantity of solution is sufficient for about 235 sqm. To 280 sqm of area is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.
(b) **Painting Old Surface G.I sheets:** If the old Paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint. If the old Paint is blistered and flaked, it shall be completely removed as described in 12.41. Such removal shall be paid for separately and, painting shall be treated as on new work.

12.25.2 Application
The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning. The second or additional coats shall be applied when the previous coat has dried.

12.25.3 All other specifications described in para 12.23 are applicable.

12.26 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS
The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive Bitumastic Paint, aluminum Paint or other type of Paint as specified in the description of the item.

12.26.1 Painting New Surface and application
Specification as specified in para 12.24 and 12.25 are applicable

12.26.1.1 Measurements: Measurements will be taken over the finished line of pipe including specials etc. in running meters; correct to a cm. Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

12.26.1.2 Rate: The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

12.26.1.3 All other specifications described in para 12.22 shall be applicable.

12.26.2 Painting on Old Surface
The specification shall be as specified in para 12.25.and 12.22 and 12.26

12.27 PAINTING WITH WOOD PRESERVATIVE
Oil type wood preservative of specified quality and approved make, conforming to IS 218 shall be used.

Generally, it shall be creosote oil type-I or Anthracene oil.

12.27.1 Painting on New Surface
(a) **Preparation of Surface:** Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted.

All roughness shall be sand papered and cleaned.

(b) **Application:** The preservative shall be applied liberally with a stout brush. The preservative shall not be daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

(c) All other specifications as described in para 12.23 shall be applicable.

12.27.2 Painting on Old Surface
The work shall be done in the same manner as on new surface except that only one coat shall be done.

12.28 COAL TARRING
The Coal tar of approved manufacture conforming to IS 290 shall be used. The tar, to every liter of
which 200 gm of unlaced lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

12.28.1 Coal Tarring on New Surface
12.28.1.1 Preparation of Surface: This shall be done as specified in para 12.24.2 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

12.28.1.2 Application: The coal tarring mixture prepared as per para 12.28 shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 liter per sqm respectively. Thinning with kerosene oil shall be suitably done to ensure this.

12.28.1.3 All other specifications as described in 12.23 shall be applicable.

12.28.2 Coal Tarring old Surface
The work shall be done in the same manner as specified in para 12.28.1 except that only one coat using 0.12 liter per sqm. Area shall be done.

12.29 SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE
The work shall include a priming coat of 'Distempering Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completion, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

12.29.1 The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade. The surface shall be prepared as described in para 12.20.1.

12.29.2 Application
(a) Primer Coat: The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

(b) Painting Coats: Spray painting coat shall be done when the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and tightly rubbed with very fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats. If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish. If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture. Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

12.29.3 All other specifications as described in para 12.23 shall be applicable.

12.30 SPRAY PAINTING WITH FLAT PAINT ON OLD SURFACE
Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

12.30.1 The flat wall Paint shall be of approved brand and manufacture and of required shade.
12.30.2 Preparation of Surface
The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and the surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down lightly.

12.30.3 Application
The Paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

12.30.4 The specifications for other details as described in para 12.22 shall be applicable.

12.31 WALL PAINTING WITH PLASTIC EMULSION PAINT
The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel. Plastic Emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

12.31.1 Painting on New Surface
The wall surface shall be prepared as specified in para 12.23.3.

12.31.1.1 Application: The number of coats shall be as specified in the item. The Paint will be applied with brush, spray or roller in the usual manner. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces. The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer’s instructions. The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

12.31.1.2 Precautions
(1) Brushes should be quickly washed in water just after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush. Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water.

(2) No oil base putties shall be used in filling cracks, holes etc in the preparation of wall for plastic emulsion painting.

(3) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening. Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

12.31.1.3 All Other specification shall be as specified in para 12.23.

12.31.2 Painting on Old Surface

12.31.2.1. Preparation of Surface: This shall be done, generally as specified in para 12.24.2. except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.
12.31.2.2 Application: The number of coats to be applied shall be as in description of item. The application shall be as specified in 12.23.3 except that thinning with water shall not normally be required.

12.31.2.3 All Other specification shall be specified under para 12.23 are applicable.

12.32 PAINTING WITH SYNTHETIC ENAMEL PAINT
Synthetic Enamel Paint shall be as per IS 2933 or conforming to IS 2933. It shall be of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary Paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

12.32.1 Painting on New Surface
Preparation of surface shall be as specified in para 12.24.2 as the case may be.

12.32.1.1 Application: The number of coats including the undercoat shall be as given in the item.
(i) Under Coat: One coat of the specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

(ii) Top Coat: Top coats of synthetic enamel Paint of required shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

12.32.1.2 All Other specified shall be as specified under para 12.22 are applicable.

12.32.2 Painting on Old Surface
(a) Preparation of Surface: If the existing Paint is firm and sound it shall be cleaned of grease, smoke etc and rubbed with sand paper to remove all loose particles. All patches and cracks shall then be treated with stopping and, filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform. If the old paint is blistered and flaked it will be necessary to completely remove the same as described in coming para 12.41. Such removal shall be paid for separately and the painting shall be treated as on new surface.

(b) Painting: The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

(c) All other specifications shall be as specified under para 12.22 are applicable.

12.33 PAINTING WITH ALUMINIUM PAINT
Aluminum Paint shall be as per IS 2339 or conforming to IS 2339. It shall be of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately. These two shall be mixed together to proper consistency before use.

12.33.1 Preparation of Surface
(a) Steel Work (New Surfaces): All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper and then surface shall be thoroughly cleaned of dust.

(b) C.G.S. Sheets (New Surfaces): The preparation of surface shall be as specified in para 12.25.1.(a)
(c) Steel Work or C.G.S. sheets (Old Surfaces): The specifications shall be as described in para 12.25.1.(b).

12.33.2 Application
The number of coats to be applied shall be as stipulated in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and all dust shall be removed before the next coat is applied. The finished surface shall present an even and uniform appearance. As
aluminum paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

12.33.3 All other specifications shall be as specified under para 12.23 are applicable.

12.34 PAINTING WITH ACID PROOF PAINT
Acid proof Paint of approved brand and manufacture and of the required shade shall be used. Preparation of surface and application shall be as specified under para 12.32 for new/old surface as the case may be.

All other specifications as specified in para in 12.23 are applicable.

12.35 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT
Ready mixed Paint as per IS 158 or conforming to IS 158. It shall be of approved brand and manufacture. It shall be black, lead free, acid-alkal-heat-water resistant. Preparation of surface and application shall be as specified in para 12.32 for painting on new or old surfaces as the case may be. The drying time between consecutive coats, however, shall be not less than 3 hours. All other specifications as specified in para 12.23 are applicable.

12.36 FLOOR PAINTING
Floor Paint of approved brand and manufacture and of the required colour shall be used.

12.36.1 Preparation of Surface
All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing washing soda in solution. The floor should then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacturer and rubbed smooth. It should be noted that the painting with floor paints shall not be done over concrete surfaces less than two years old. Old surface shall be prepared as specified in para 12.32.

12.36.2 Application
The number of coats as given in the description of the item shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring should be brought into use after a week of completion of final coat so that the painted surface can thoroughly harden.

12.36.3 Measurement
Measurements shall be as per actual length and breadth being measured correct to a cm. The details given under para 12.23.5 shall be applicable.

12.36.4 All other specifications as specified in para 12.23 are applicable.

12.37 VARNISHING
Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler. Varnish (conforming to IS 347 for the finishing and undercoats shall be of the approved manufacturer.

12.37.1 Varnishing on New Surfaces
12.37.1.1 Preparation of Surface: New wood work to be varnished shall have been finished smooth with a carpenter’s plane. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty. The fillings when dry shall be rubbed down with a carpenter’s file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

12.37.1.2 Sizing or Transparent Wood Filler Coat: The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

(a) Sizing: When sizing is to be done, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then
be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow. Any joining up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is not advisable on floors, table tops and other horizontal surfaces likely to carry wet household utensils which are likely to disturb the size coatings and thus expose bare wood. Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

(b) **Transparent Wood Filler Coat:** Where instead of glue sizing, transparent wood filler application is given in the item, then the surface prepared as described in para 12.37.2-1 shall be given as application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

12.37.1.3 **Application of Varnish:** The number of coats to be applied shall be as given in the description of the item. The undercoat shall be with a flattening varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhances the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, latter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnish shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean. Rubbing down and flattening the surface shall be done after each coat except the final coat with fine sand paper. The work shall be allowed to dry away from droughts and damp air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc. Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

12.37.1.4 All other specifications as specified in para 12.23 are applicable.

12.37.2 Varnishing on Old Surface

12.37.2.1 **Preparation of Surface:** When the old varnished surface is firm and sound, then it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in para 12.37.1.1. The entire surface shall then be rubbed down smooth with sand paper and wiped clean. If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish as described in coming para 12.41 and such removal shall be paid for separately outside the rate for varnishing. Further the varnishing itself will have to be done like new work and will be paid for as such.

12.37.2.2 **Application:** The specification shall be same as described in para 12.37.1.3 as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

12.37.2.3 All other specifications as specified in para 12.23 are applicable.

12.38 FRENCH SPIRIT POLISHING

Pure shellac conforming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 liter of spirit. Suitable pigment shall be added to get the required shade. Ready made polish conforming to IS 348 can also be used.
12.38.1 Polishing New Surface
12.38.1.1 Preparation of Surface: The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier’s putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit @1.5 Kg of whiting per liter of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

12.38.1.2 Application: The number of coats of polish to be applied shall be as described in the item. A pad of woolen cloth covered by a fine doth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

12.38.1.3 Measurements, Rate and other details shall be as specified in para 12.23 are applicable.

12.38.2 Polishing Old Surface
12.38.2.1 Preparation of Surface: If the old polished surface is not much soiled it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper. If the old polished surface is much soiled then it will be necessary to remove the entire polish as described in para 12.41 and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to do done like new work and will be paid for as such.

12.38.2.2 Application: The specifications shall be same as described in para 12.38.1.2 as far as applicable.

12.38.2.3 Measurements, Rate and other details shall be as specified in para 12.23 are applicable.

12.39 BEES WAXING OR POLISHING WITH READY MADE WAX POLISH
The polishing shall be done with bees waxing prepared locally or with ready made wax polish of approved brand and manufacture, as given in the description of item. Where bees waxing are to be prepared locally, the following specifications for the same shall apply. Pure bees wax free from paraffin or steering adulterants shall be used. Its specific gravity shall be 0.965 to 0.969 and melting point shall be 63 degree C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2:1.5:1:0.5 by weight. The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and the entire mixture shall be well stirred.

12.39.1 Waxing New Surface
12.39.1.1 Preparation of Surface : Preparation of surface shall be as described in para 12.37.1.1 with the exception that knotting, holes and cracks shall be stopped with a mixture of fine saw dust formed of the wood being treated, beaten up with sufficient bees wax to give it cohesion.

12.39.1.2 Application: The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The surface is then rubbed continuously for half an hour. When the surface is quite dry, a second coat shall be applied in the same manner and rubbed continuously for one hour or until the surface is dry. The final coat shall then be applied and rubbed for two hours (more if necessary) until the surface has assumed a uniform gloss and is dry, showing no sign of stickiness. The final polish depends, largely on the amount of rubbing which should be continuous and with uniform pressure with frequent changes in the direction.

12.39.1.3 Other details shall be as specified in para 13.23 are applicable.

12.39.2 Waxing Old Surfaces
12.39.2.1 Preparation of Surface: The wood work shall be cleaned of all smoke and grease by washing with lime water. The surface shall then be washed with soap and completely dried. Then it
shall be prepared smooth as specified in para 12.37.1.1.

12.39.2.2 Application. The polish shall be applied in the manner specified in para 12.39, 1.2. In this case one or two coats shall be applied as necessary to get uniform gloss, instead of three coats in the case of new work.

12.39.2.3 Other details shall be as specified in para 12.22 are applicable.

12.40 LETTERING WITH PAINT

Black, Japan Paint (conforming to IS 341) or ready mixed Paint as ordered by the Engineer-in-Charge shall be used. The Paint shall be of approved brand and manufacture. Ordinary ready mixed Paint shall be of the shade required by the Engineer-in-Charge.

12.40. Lettering on New Surface

12.40.1 Application: The letters and figures shall be to the heights and width as ordered by the Engineer-in-Charge. These shall be stenciled or drawn in pencil and got approved before painting. They shall be of uniform in size and finished neatly. The edges shall be straight or in pleasant smooth curves. The Lettering shall be vertical or slanting as required and its thickness shall be as approved by the Engineer-in-charge. Two or more coats of Paint shall be applied till uniform colour and glossy finish are obtained.

12.40.2 Measurements: Measurements shall be taken in terms of letter cm (the measurement relates to the vertical height of the lettering). The letter heights shall be measured correct to a cm. Dots, dashes, punctuations and other similar marks or lines shall not be measured for payment. In Devanagari Script Dots & Matras occurring with the letters shall not be measured. Half letter shall be measured as full letter. The height of letters shall be measured excluding the Matras projecting above the heading and Matras below the letters.

12.40.3 Rate: Rate shall include the cost of all labour and materials involved in the operations described above. The rate per cm height of letter shall hold well irrespective of the width of the letters or figures or the thickness of the lettering. The same rate will apply irrespective of whether black Japan or ready mixed Paint of any shade as required is used.

12.40.2 Relettering on Old Surface

Painting shall be done over the existing letters and shall accurately follow their lines and curves. One or more coat of Paints shall be applied till a uniform colour and glossy finish is obtained. Measurements and Rate shall be as specified under para 12.40.2 are applicable.

12.41 REMOVING OLD PAINT

12.41.1 With Patent Paint Remover: - Patent Paint remover shall consist of volatile organic liquids thickened with waxes and other ingredients to retard the evaporation of the liquid and to enable a substantial layer of remover to be applied to the surface. The Paint remover shall be of a brand and manufacture approved by the Engineer-in-Charge. It shall be free from alkaline matter and non-caustic so that it can be handled by workmen without injury. It shall be of non inflammable quality as far as possible.

12.41.1 Application: Paint remover shall be used where burning off with blow lamp is not suitable. The Paint remover shall be applied liberally with a brush and allowed to remain on the surface for a period depending on the particular brand of remover used and on the thickness of the Paint coating to be removed. When the Paint film lifts and wrinkles under the action of the remover it shall be stripped with a sharp instrument. If the film is not thoroughly removed a second coat of remover may be applied if necessary over such patches and then the film thoroughly scrapped. After the surface has been stripped, it shall be washed down with mineral turpentine to remove all traces of paraffin wax, which forms one of the ingredients of patent Paint remover and which if left in place will prevent the Paint from drying. The cleaned surface shall be suitably prepared for application of Paint or other finish.

12.41.2 Precautions: Where the Paint remover used is of the inflammable type, suitable precaution against risk of fire shall be taken. Neighboring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.
12.41.1.3 **Preparation of Surface:** The surface shall then be prepared as described in para 12.24.2.

12.41.1.4 **Measurements:** Specification for 12.23.5 shall hold good.

12.41.1.5 **Rate:** Rate shall include the cost of all labour and materials involved in all operations described above.

12.41.2 With Caustic Soda Solution

12.41.2.1 **Application:** Caustic soda dissolved with 48 times its volume of water shall be applied to the old Paint with a brush and when the Paint film lifts and wrinkles it shall be thoroughly scrapped off in the same way as described in para 12.41.1.2. After the surface has been stripped thoroughly, it shall be rinsed with several chances of clean water to remove all traces of alkali, which if allowed remaining are liable to spoil the new Paint applied over it. A little acetic acid or vinegar added to the rinsing water helps to neutralize any remaining alkali.

12.41.2.2 **Precautions:** Caustic soda as its name implies is a corrosive liquid and care should be taken to see that no liquid spills over the skin or clothing.

12.41.2.3 all other specification for Preparation of Surface, Measurements, Rate and other details shall be as specified under para 12.41.1 are applicable.

12.41.3 with Blow Lamp

12.41.3.1 The Paint shall be removed either with a blow lamp or with air acetylene equipment. The flame shall be allowed to play upon the Paint Just enough to soften it without charring either the Paint or the background. The softened Paint shall then be removed with a stripping knife following the flame as it is moved up the surface. Burning off shall begin at the bottom of the vertical surface and shall proceed upwards.

12.41.3.2 **Precautions:** Removal with blow lamp shall not be done on narrow or carved under cut surfaces or where there is risk of damage to neighboring materials such as panes in glazed windows. Neighboring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

12.41.3.3 all other specification Preparation of surface, Measurements, Rate and other details shall be as described under para 12.41.1 are applicable.

12.42 WASHED STONE GRIT PLASTER

12.42.1 Scaffolding and preparation of surface shall be as specified in para 12.1.1 are applicable,

12.42.2 **Materials**

(a) Stone chippings obtained by crushing hard stone shall be free of dust and deleterious material and shall be thoroughly washed with water and sieved before used. 10 mm nominal size stone chippings, where specified, shall pass 100% through 12.5 mm sieve and fully retained on 6.3 mm sieve.

(b) **Mortar:** Cement mortar for under coat and cement mortar to be mixed with stone chippings for top coat shall be as specified under (chapter mortar).

12.42.3 **Application of Plaster**

12.42.3.1 **12 mm Under Coat:** Under coat of cement mortar 1:4 (1 cement: 4 coarse sand) shall be applied as specified in 13.1.3 except that the finishing, after the mortar has been brought to level with the wooden straight edge, shall be done with wooden float only. The surface shall be further roughened by furrowing with a scratching tool. Furrowing shall be done diagonally both ways and shall be about 2 mm deep to provide a key for the top coat. The scratched lines shall not be more than 10 cm apart. The surface shall be kept wet till top coat is applied.

12.42.3.2 **15 mm Top Coat:** Top coat comprising cement mortar and stone chippings shall have an over all proportion of 1:0.5:2 (1 cement: 0.5 coarse sand: 2 stone chippings 10 mm nominal size) or as specified. The top coat shall be applied a day or two after the under coat has taken the initial set. The surface of the under coat shall be cleaned and a coat of cement slurry at 2 kg of cement per sqm shall be applied before the application of coat. The top coat shall be applied in uniform thickness on the under coat after the application of slurry and sufficiently pressed with wooden float for proper bonding with the under coat. Vacant space, if any shall be filled with the specified mix.
12.42.4 Finish
The top coat of plaster shall be finished to a true and plumb surface. The surface shall be tested frequently as the work precedes with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. All the corners angles and junctions shall be truly vertical or horizontal as the case may be. Rounding or chamfering of corners junctions etc. Where required shall be true to template. Finished surface of the top coat after the mix has taken the initial set, shall be scrubbed and washed with suitable brushes and plain water. Scrubbing and washing shall continue till the stone chippings are sufficiently exposed. Stone chippings which may come out while scrubbing shall be replaced using the specified mortar mix. A sample of the washed stone grit plaster shall be got approved from the Engineer-In-Charge.

12.42.5 Grooves
Grooves of size 15 mm x 15 mm or as specified shall be provided as shown on the approved drawing or as required by the Engineer-In-Charge. Tapered wooden battens to match the size and shape of the grooves shall be fixed on the under coat with nails before the application of the top coat and these shall be removed carefully so that the edges of the panels of top coat are not damaged. Damage, if any, shall be made good by the contractor.

12.42.6 Curing
The curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days. During this period, it shall be suitably protected from all damages at the contractor's expense.

12.42.7 Measurements
(a) Length and breadth shall be measured correct to the nearest cm and the area shall be calculated in sqm correct to two places of decimal.
(b) Measurements shall be taken for the work actually done with deductions for all openings and addition for all jambs soffits and sills. However, no deduction is to be made for the grooves provided as specified in para 12.42.5.
(c) Washed stone grit plaster on circular surfaces not exceeding 6 m in radius and on external surfaces at a height greater than 10 m shall be measured separately.

12.42.8 Rates
The rates shall include the cost of all labour and materials involved in all the operations described above except for providing grooves. The length of grooves shall be measured in running meters and paid for separately.

12.43 GYPSUM LIGHT WEIGHT PLASTER
12.43.1 Scaffolding and preparation of surface shall be as specified in para 12.11 are applicable.

12.43.2 Materials
Premixed light weight plasters essentially consist of retarded hemihydrates gypsum plaster and light weight aggregate which are characterized by low density, high thermal insulation and sound absorption properties. Other additions may be incorporated to impart desired properties. The physical and chemical requirements shall conform to IS 2547 (Pt. II). The minimum recommended water-premixed plaster ratio is 1:2 as per standard practice or as recommended by the manufacturers.

12.43.3 Application of Plaster
Surface shall be prepared as given in para 12.1.2 and 12.4.1 Application of plaster shall be as specified in para 12.1.4 are applicable.

12.43.4 Thickness
The average thickness of the plaster shall not be less than 12 mm whether wall treated is of brick/block/RCC work.

12.43.6 Finish
Finishing and measurement shall be specified as in para 12.1 and 12.1.9 are applicable.

12.43.7 Rate
Rate shall include the cost of all labour & material involved in all the operations described above.
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13.1 REPAIRS TO PLASTER

13.1.1 It includes cutting of patch, plastering and preparing the wall surface, the area of Patches 2.50 square meters and less in area shall be measured. Plastering in patches over 2.5 square meters in area shall be paid for at the rate as applicable to new work under sub head 12.0.

13.1.2 Scaffolding
Where Scaffolding operation as required for the proper execution of the repairing work shall be erected. If with the help of ladder or jhool work can be done safely then scaffolding shall not be permitted.

13.1.3 Cutting
Where the existing plasters has cracked, crumbled or sounds hollow shall be removed. The patch shall be cut out to a square or rectangular in shape at position marked on the wall edges shall be slightly under cut to provide a neat joint on as directed by the engineering in charge.

13.1.4 Preparation of Surface
(a) In masonry surface the joints which become exposed after removal of old plaster shall be raked out to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking of joints shall be carried out uniformly with a raking tool and not with a basuli. The loose mortar dusted off. The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced.

(b) In case of concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster had been cut out and pock marked as described in para 12.1.2. The surface shall be washed and cleaned and kept wet till plastering is commenced.

13.1.5 Application of Plaster
The Mortar of specified mix and application shall be as described for single coat plaster work under Chapter 12. The surface shall be finished even and flush and matching with the old surrounding plaster. At junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified in chapter 12.0.

All dismantled material & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

13.1.6 Protective Measure
Doors, windows, floors, articles of furniture-etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

13.1.7 Curing
Curing shall be done on plaster work with special reference to the particular type of plaster mix as described under chapter 12.

13.1.8 Finishing
When the plaster work is thoroughly cured and dried than the surface shall be white washed or colour washed to suit the existing finishing as required unless specified.

13.1.9 Measurements
Length and breadth shall be measured correct to a cm. The area shall be calculated in square meter correct to two places of decimal. Patches below 0.05 square meters in area shall not be measured for payment.

Pre-measurements of the patches to be plastered shall be recorded after the old plaster has been cut and wall surface prepared.

13.1.10 Rate
The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled material.
13.2 FIXING DOOR, WINDOW OR CLERESTORY WINDOW CHOWKHATS IN EXISTING OPENING

13.2.1 Making Holes
Where the door frames is without sills then holes 40 mm deep shall be made in the floor for fixing the lower end of verticals of the frames. For doors with sills, the sill plates shall be partly fixed in the floor so that they project above the floor to the height as directed by the Engineer-in-Charge.

In the masonry for embedding hold fasts of doors, windows or clerestory windows, the required number of holes at the correct positions shall be cut out. The size of the holes shall be such that the Chowkhats with the hold-fasts can be conveniently erected in position. Where required, masonry shall be chipped uniformly to facilitate easy insertion of the frame in the opening.

Special attention and care are required when holes are made in load bearing pillars or wall portions separated by openings to ensure that beams etc. supported by them are properly propped up. In such portions cutting holes shall be done on one side at a time. The sides of the holes shall be truly parallel and perpendicular to the plane of the wall. Due care shall be taken, not to disturb the adjoining masonry and the masonry under the bearings of lintels and arches etc. spanning the opening. The holes shall then be cleaned of all dust, mortar and brick or stone pieces and thoroughly wetted.

13.2.2 Fixing
The sides of Chowkhats of door or window abutting against or to be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The Chowkhats shall then be inserted in position with their bolt tight hold-fasts. The Chowkhats shall then be adjusted to proper line and plumb and secured in position by temporary bracing which shall not be disturbed or removed until the hold fasts are embedded in the masonry and the concrete block has set. The concrete blocks of cement concrete 1:3:6 mixes (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) shall be used for embedding bold fasts. For 35 cm long hold fasts minimum size of concrete block shall be 30 x 10 x 15 cm. The chase cut in the floor shall be cut square and construction joint shall be provided filled in with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth at the top and finished to match the existing type of floor.

13.2.3 Finishing
After fixing hold-fasts the surface has sufficiently dried it shall be cleaned of dust etc. wetted, and then be plastered with cement mortar 1:4 (1 cement: 4 fine sand) flush and matching with the surrounding plaster work. In case of exposed brick work, stone work, the finishing shall be done to match the surrounding. Any other portion of the wall opening, if damaged, shall be repaired in similar way.

After the cement plaster patches have been thoroughly cured and dried, they shall either be white washed or colour washed as required unless otherwise specified. All material obtain them cutting etc. shall be disposed off to the nearest dumping ground.

13.2.4 Measurements
The Chowkhats of doors, window and clerestory windows shall be enumerated separately.

13.2.5 Rate,
The rate shall apply irrespective of the size of the Chowkhats upto a maximum area of opening 3.75 square meters for doors, 2.5 square meters for windows and 1.2 square meters for clerestory windows. The rate is inclusive of labour and materials involved in all the operations described above, excluding, cost of Chowkhats and, cost of supplying and fixing the hold-fasts including C.C. block and bolts.

13.3 FIXING CHOWKHATS IN EXISTING OPENING IN BRICKS / RCC WALL WITH DASH FASTNERS
All the specification given in pera 131.2 (13.2.1, 13.2.3, 13.2.4, 13.2.5) except for fixing

13.3.1 Specification for fixing:-
The sides of Chowkhats of door, window or clerestory window abutting against or to be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The Chowkhats shall then be inserted in position tight. The Chowkhats shall then be adjusted to proper line and plumb and secured in position by temporary bracing which shall not be disturbed or removed until the fastners are embedded in the masonry /RCC wall
13.4 MAKING OPENING IN THE MASONRY CONSTRUCTION AND FIXING CHOWKHATS FOR DOORS, WINDOWS AND CLERESTORY WINDOWS.

13.4.1 Precautions
Before making opening it is necessary to examine that :-
(i) The wall exclusive of opening is adequate to take the load coming on the structure.
(ii) All the structural members supported on the walls which have direct bearing over the area in which opening is to be made, shall be properly supported with props to relieve the load from masonry wall till the lintel over the opening is strong enough to take the load.
(iii) Care should also be taken not to disturb the adjoining masonry.
(iv) All precautions as described in Chapter 14.0, (Demolition and Dismantling) should be followed in case of dismantling the external walls.
(v) The portion to be dismantled may be clearly marked on both sides of the wall. Dismantling shall be carried out from top to bottom within the marked area.
(vi) The sides of the opening shall be as far as possible, parallel and perpendicular to the plane of wall.

13.4.2 Making Opening
The openings for fixing door/window frames shall be to the extent of accommodating the hold fast. The hold fasts shall be fixed in cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 stone aggregate 20 mm nominal size) or in masonry as required. Where only opening is to be made in the masonry, the width of the opening shall be such that the sides of the masonry can be built true to line and plumb and such masonry built shall conform to the specifications of the particular type of masonry in which the opening is made with particular reference to size of corner stones etc. In order to get continuity with old masonry, proper key shall be provided and height of the opening shall be such that it can accommodate the required depth of the RCC lintel also.

The sides of opening in masonry shall be cleaned of all dust, mortar, brick bats/loose stones, chips etc. and the surface left rough and thoroughly wetted. The lintel shall be invariably cast first in the opening made for the purpose. One side of the shuttering shall be kept open in the beginning till the concrete is laid. The shuttering shall then be fixed for half of the opening and concreting completed. Curing of lintel casted shall be done for a minimum period of 7 days. Precast RCC lintel or R.S. Joist may also be used if directed by the Engineer-in-Charge.

13.4.2 Fixing Chowkhats
Fixing of Chowkhats shall be done as specified in 13.2.2.

13.4.3 Finishing
After the surface of the sides of masonry opening and lintel are sufficiently dry and set, it shall be cleaned free of dust, loose mortar etc. and wetted thoroughly. It shall then be plastered or pointed as required flush with the surrounding masonry work. Any other portion of the wall if damaged shall be finished in similar way.

After the cement plaster/pointing has been thoroughly cured and have dried the surface shall be either white or colour washed/painted as required. The surface of the wall which is spoiled due to splashing of mortar shall be cleaned.

13.4.4 Measurements
The openings made for doors, windows, clerestory windows shall be measured correct to cms and area shall be calculated in square meters correct to two places of decimal.

13.4.5 Rate
The rate shall apply per.sqm of opening. The rate is inclusive of labour and material involved in all the operations described above.

Cost of Chowkhats, cost of CC blocks, cost of supplying the hold-fasts bolts, cost of R.C.C lintel or R.S. Joist which shall be paid for separately.

13.5 RENEWING FLOATING GLASS PANELS WITH PUTTY AND NAILS

13.5.1 Removing Broken Panels and floating
Old putty shall be raked out with hack knife. The (small nails without head) and pieces of broken glass shall be removed from the rebates of the sash bars. The pieces of glass panels as found useful shall be handed over to the Engineer-in-Charge. No glass shall be inserted in frames until they have been
primed and prepared for painting so that the wood may not draw oil out of the putty. The floating glass panels shall conform to specifications described in IS 14900.

13.5.2 Fixing
The floating glass panels shall be so cut that it fits slightly loose in the frame and as specified in A&B of IS 14900. A thin layer of Putty conforming to IS 419 shall be drawn along the inner edge of the rebate, for bedding the back of the glass panels. The glass panels shall then be put in position, pressed home against the thin layer of the putty, and secured in rebate by new brads. The brads shall not be spaced more than 7.5 cm from each corner and not more than 15 cm apart. The putty shall then be applied in the rebate uniformly, sloping from the inner edge of the rebate. In doing this care shall be taken to keep the putty a little within the inner edge of the rebate and surplus putty removed so that none of it is seen through the glass from the inside. The putty so filled in the rebates shall be leveled smooth and finished in a straight line. When dried the putty shall be covered with a coat of paint of approved quality and shade to match the existing finish of joinery work.

The floating glass panels shall be cleaned with methylated spirit. All splashings or droppings of washing and paints shall be removed. All rubbish and unserviceable materials shall be disposed off to the dumping ground promptly as per the direction of Engineer-in-Charge.

Thickness and Tolerance of Floating Glass

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 mm</td>
<td>± 0.3 mm</td>
</tr>
<tr>
<td>5 mm</td>
<td>± 0.3 mm</td>
</tr>
<tr>
<td>6 mm</td>
<td>± 0.3 mm</td>
</tr>
</tbody>
</table>

Note: Frosted glass panels should be replaced with frosted glass panels. These shall be fixed with frosted face on the inside.

13.5.3 Measurements
Length and breadth of glass panels shall be measured correct to a cm. The area of the glass panels as fixed shall be calculated in square meter correct to two places of decimal.

13.5.4 Rate
The rate shall include the cost of labour and materials involved in all the operations described above.

13.6 RENEWING FLOATING GLASS PANELS WITH WOODEN FILLETS
13.6.1 Removing Broken Glass Panels and glazing
The specifications shall be the same as in para 13.5.1 except that the wooden fillets including nails shall be taken out carefully. The specifications for glass panels and their fixing shall be the same as per IS 14900. The fillet shall either be fixed flush or projected uniformly to match with the existing work by means of nails (brads).

13.6.2 Finishing
The new fillet provided shall be painted or finished otherwise to match with the existing finish of the joinery work. The glass panels shall be cleaned with methylated spirit of all sorts of splashing and droppings of wash and paints. All rubbish and unserviceable materials shall be disposed off in the dumping ground promptly.

13.6.3 Measurements
Length and breadth of glass panels shall be measured correct to a cm. The area of the glass panels as fixed shall be calculated in square meter correct to two places of decimal. The new wooden fillets fixed shall be measured in running meters correct to a cm.

13.6.4 Rate
The rates shall include the cost of labour and material involved in all the operations described above except that the cost of new wooden fillets used in the work and their finishing shall be paid for separately.

13.7 RENEWING FLOATING GLASS PANELS AND REFIXING EXISTING WOODEN FILLETS
The specifications shall be same as described in 13.6 above.

13.8 PROVIDING NEW WOODEN FILLETS
13.8.1 The fillets shall be of wood, as specified in the item of work; these shall be cut and planed smooth to the required shape and dimensions.

13.8.2 Fixing
The specifications for glass panels and their fixing shall be the same as given in para 8.6.4.6. The fillet shall either be fixed flush or projected uniformly to match the existing work. The fillet shall be painted or finished otherwise to match with the existing finish of the joinery work. The glass panels shall be cleaned with methylated spirit of all sorts of splashing and dropping of wash and paints.

13.8.3 Measurements
The fillets shall be measured in running meters. The lengths shall be measured correct to a cm.

13.8.4 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above. The rate shall also include the cost of removal of worn out fillets, when these are met with in old work. The rate shall vary according to the class of wood used.

13.9 RENEWAL OF OLD PUTTY OF GLASS PANELS
13.9.1 The old putty shall be removed as specified in para 13.5.1 and new putty fixed as specified in para 13.5.3.

13.9.2 Measurements
The work shall be measured in running meters. The length along the rebate shall be measured correct to a cm.

13.9.3 Rate
The rate shall include the cost of labour and materials involved in all the operations described above.

13.10 REFIXING OLD GLASS PANELS WITH PUTTY AND NAILS
13.10.1 Specification same as described in para 13.5 above. Except for the glass panels, old glass panels will be used for which nothing extra will be paid.

13.11 FIXING OLD GLASS PANELS WITH WOODEN FILLETS
13.11.1 Specifications same as described in para no. 13.6 above except for the glass panels. Old glass panels will be used for which nothing extra shall be paid.

13.12 FIXING FAN CLAMPS IN EXISTING R.C.C. SLABS
The fan clamps to be fixed in an existing R.C.C. slab shall be of type shown in Fig. These shall be made of 16 mm dia M.S. bar.

---

![Diagram of Fan Clamps](image)

*Drawing Not to Scale
All dimensions are in mm*
A 15 x 7.5 cm size chase shall be cut from the ceiling to expose the reinforcement and up to 2.5 cm clear round the reinforcement bar as directed. This shall be done without any damage to adjoining portion of the ceiling. The two arms at the ends of the clamps shall be passed through the space over the reinforcement bar from the bottom of the slab. Then the two arms shall be bent down about 1.5 cm by means of a crow bar. The clamp shall be held in position and chase in the ceiling filled with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size). The ceiling shall then be finished to match the existing surface and properly cured. The exposed portion of the clamp shall be given two or more coats of paint including one priming coat of shade as directed by the Engineer-in-Charge.

13.12.2 Measurements and Rate
Clamps shall be counted in numbers. The rate per fan clamp shall include the cost of labour and materials involved in all the operations described above. The rate shall apply irrespective of the thickness of the slab.

13.13 RENEWING WOODEN BATTENS / BEAMS IN ROOFS
13.13.1 Dismantling Wooden Battens / Beams
The dismantling shall be done as described in para 14.1. Propping and bracing as directed should be done adequately and members required to be dismantled should be removed carefully including nails/bolts etc. and dismantling of masonry wall. The dismantled members should not be thrown or dropped but lowered with ropes carefully and stacked properly.

13.13.2 Relaying of Wooden Battens
The wooden battens/beams of required section and size should be placed at proper interval and surface of the wooden batten/beams shall be painted with oil type wood preservative of approved brand and manufacture and as per the direction of Engineer-in-Charge.

13.13.4 Measurement
The work shall be measured in cubic meters. The length, breadth and depth shall be measured correct to a cm.

13.13.5 Rate
The rate shall include the cost of materials and labour involved in the operations described above.

13.14 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS All the specification shall be applicable as given in the chapter of wood work para (8.5)

13.14.1 Framework:
All the specification shall be applicable as given in the chapter of wood work para 8.5.1. In addition to these the dimension of component of frame work are given below:

### TABLE - 1 Dimensions of Components of Frame Work

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Width in mm</th>
<th>Thickness in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. DOOR SHUTTERS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Stile, top and freeze rail</td>
<td>100</td>
<td>35 or 40</td>
</tr>
<tr>
<td>(b)</td>
<td>Lock rail</td>
<td>150</td>
<td>35 or 40</td>
</tr>
<tr>
<td>(c)</td>
<td>Bottom rail</td>
<td>200</td>
<td>35 or 40</td>
</tr>
<tr>
<td>(d)</td>
<td>Muntin</td>
<td>100</td>
<td>35 or 40</td>
</tr>
<tr>
<td>(e)</td>
<td>Glazing bar</td>
<td>40</td>
<td>35 or 40</td>
</tr>
<tr>
<td>B. WINDOW, VENTILATOR &amp; CUPBOARD SHUTTERS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Stile, top and freeze rail</td>
<td>80</td>
<td>20, 25 or 30</td>
</tr>
<tr>
<td>(b)</td>
<td>Bottom rail</td>
<td>80</td>
<td>20, 25 or 30</td>
</tr>
<tr>
<td>(c)</td>
<td>Muntin</td>
<td>60</td>
<td>20, 25 or 30</td>
</tr>
<tr>
<td>(d)</td>
<td>Glazing bar</td>
<td>40</td>
<td>20, 25 or 30</td>
</tr>
</tbody>
</table>

13.14.2 Gluing of Joints:
All the specification shall be applicable as given in the chapter of wood work para 8.5.1.2 & 8.5.1.3
13.14.3 Rebating:-
All the specification shall be applicable as given in the chapter of wood work para 8.5.3

13.14.4 Paneling:-
All the specification shall be applicable as given in the chapter of wood work para 8.5.4

13.15 Timber Panels:-
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(a)

13.15.1 Classification of panel:-
(a) Plywood Panels:
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(b)

(b) Block Board Panels:
The black board used for paneling of shutters shall be grade 1 (Exterior Grade) bonded with BWP type synthetic resin adhesives as specified in para 8.2.2.(b) and each panel shall be single piece of thickness 12 mm unless otherwise specified.

(c) Veneered Particle Board Panels:
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(c)

(d) Fiber Board Panels:
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(d)

(e) Wire Gauze Panels:
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(e)

(f) Glass Panels:
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(f)

13.16. Preparation of putty
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(g)

13.16.1. Finishing:
All the specification shall be applicable as given in the chapter of wood work para 8.5.4.(h)

13.16.2 Beading:-
All the specification shall be applicable as given in the chapter of wood work para 8.5.5

13.16.3 Machine or Factory made Shutters:
All the specification shall be applicable as given in the chapter of wood work para 8.5.6

13.16.4 Fixing of Shutters:-
All the specification shall be applicable as given in the chapter of wood work para 8.5.7

13.16.5 Fittings:-
All the specification shall be applicable as given in the chapter of wood work para 8.5.8

13.16.6 Wooden Cleats and Blocks
All the specification shall be applicable as given in the chapter of wood work para 8.5.9

13.16.7 Measurements
All the specification shall be applicable as given in the chapter of wood work para 8.5.10

13.16.8 Frame Work of Shutters:
All the specification shall be applicable as given in the chapter of wood work para 8.5.10.(a)

13.16.9. Paneling of each type or for glazed panel length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sqm. The portion of the panel inserts or glazed panel inside the grooves or rebates shall not be measured for payment.
13.16.10 Rate
All the specification shall be applicable as given in the chapter of wood work para 8.5.11

13.17 TRELLIS (JAFFRI) WORK
All the specification shall be applicable as given in the chapter of wood work para 8.10.

13.17.1 Plain Trellis (Jaffri)
All the specification shall be applicable as given in the chapter of wood work para 8.10.1.

13.17.2 Trellis (Jaffri) Doors and Windows Shutters
The shutter frame of specified timber shall consist of two stiles and top, lock and bottom rails, each of section 75 x 35 mm unless otherwise specified. The stiles and rails shall be properly mortised and tanned. The tenons shall pass through the stiles for at least 3/4th of the width of the stile. Before joining the shutter frame shall be assembled and passed by the Engineer-in-Charge. The joints shall be pressed and secured by bamboo pins of about 6 mm diameter. To this frame, plain trellis (Jaffri) work as specified in para 8.11.1 shall be fixed as shown in the drawings and fixing, fittings, wooden cleats and blocks shall be provided as specified para 8.6.

13.17.3 Measurements
In case of plain trellis and trellis shutters the width and height shall be measured overall correct to a cm. The area shall be calculated in square meters nearest to two places of decimal. In case of shutters, the measurement shall be as specified in para 8.11.2.

13.17.4 Rate
It includes the cost of materials and labour required in all the operations described above.

13.18 FITTINGS
All the specification shall be applicable as given in the chapter of wood work para 8.13
(a) Mild Steel Fittings
All the specification shall be applicable as given in the chapter of wood work para 8.13(a)

(b) Brass Fittings
All the specification shall be applicable as given in the chapter of wood work para 8.13(b)

(c) Aluminum Fittings
All the specification shall be applicable as given in the chapter of wood work para 8.13(c)

13.18.1 Butt Hinges
(a) Cast Brass Butt Hinges: These shall be light/ordinary or heavy well made and free from flaws and defects of all kinds and finished bright or chromium plated or oxidized or as specified and generally conform to IS 205.

Hinge Pin: Hinge pin shall be made of brass or of phosphor bronze. The hinge pins shall be firmly riveted and shall be properly finished. The movement of the hinge pin shall be free, easy, and square and shall not have any play or shake.

Knuckles: The number of knuckles in each hinge shall not be less than five and the number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

Screw Holes: The screw holes shall be clean and counter sunk and of the specified size for different types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

(b) Sampling and Criteria for Conformity: Butt hinges for testing shall be taken at random from at least 10% of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given as below table.
### TABLE 13.2

<table>
<thead>
<tr>
<th>Lot size</th>
<th>Sample Size</th>
<th>Permissible No. of defective hinges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 200</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>201 to 300</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>301 to 500</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>501 to 800</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>801 and above</td>
<td>55</td>
<td>3</td>
</tr>
</tbody>
</table>

**Note:** Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

### 13.18.2 Spring Hinges: (Single or double acting)
These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and conform to IS 453. Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

(a) When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.

(b) The door shall require a force of 2.0 ± 0.5 kg for 100 mm hinges and 3.0 ± 0.5 kg for 125 mm and 150 mm hinges at a distance of 4.5 cm from the hinge pin to move the door through 90°. The size of spring hinge shall be taken as the length of the plate.

13.18.2.1 Type of spring hinges:-
(a) *Mild Steel:* The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and riveted, or from solid drawn tube of thickness, pressed to from the two casing & shall be stove enameled black copper oxidized or as specified.

(b) *Cast Brass:* The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness & shall be satin, bright nickel plated copper oxidized or as specified.

13.18.2.2 Sampling: The number of spring hinges shall be selected from the lot and this number shall depend on the size of the lot and shall be in accordance with Table as below.

### TABLE 13.3

<table>
<thead>
<tr>
<th>Lot size</th>
<th>Sample Size</th>
<th>Permissible No. of defective spring hinges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 25</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>26 to 50</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>51 to 100</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>101 to 200</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>201 to 300</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>301 to 500</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>501 to 800</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>801 and above</td>
<td>55</td>
<td>3</td>
</tr>
</tbody>
</table>

13.18.3 Flush Bolts (Fig. 13.3)
These shall generally conform to IS 5187. These shall be of cast brass, cast aluminum alloy or extruded aluminum alloy as specified. Only one. Material shall be used in the manufacture of all the components of flush bolts except spring which shall be of phosphor bronze or steel strip. *When* the rod is completely in its maximum bolting position it shall be retained in that position by the spring the length...
of the bolt shall be such that, when the bolt is pulled down, the top of the bolt shall be flush with the top of the lip face. The top of the bolt shall be given a taper of 45° to enable easy pull or push.

Brass flush bolts shall be satin or bright polished. Alternatively they may be nickel or chromium plated as specified in IS 4827 or copper oxidized in accordance with IS 1378. Aluminum flush bolts shall be anodized and the quality of the anodized finish shall not be less than grade AC 15 of IS 1868.

13.18.4 Floor Door Stopper (Fig. 13.4)
The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidized or as specified. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body or housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or, of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminum stopper shall be anodized and anodic film shall not be less than grade AC-10 of IS 1868.

13.18.5 Hanging Rubber Door Stopper
These shall be of cast brass, finished bright, chromium plated or as specified. Aluminum stopper shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

13.18.6 Casement Brass Stays (Straight Peg Type) (Fig. 13.5)
13.18.6.1 These shall be made of mild steel, cast brass, aluminum (extruded section) or plastic (Polypropylene):
(a) Mild steel casement stays shall be a copper oxidized (black finish) or as specified.
(b) Cast brass stays shall be finished bright or chromium plated or as specified.
(c) Aluminum stays shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminum and M.S. stays shall be made from channel section the shape and pattern of the stays shall be approved by the Engineer-in-charge. The stays shall not weigh less than that indicated below:

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Weight (kg each)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>0.24</td>
</tr>
<tr>
<td>250</td>
<td>0.28</td>
</tr>
<tr>
<td>300</td>
<td>0.33</td>
</tr>
</tbody>
</table>

(d) The plastic (Polypropylene) stays shall conform to IS 6318.

13.18.7 Fan Light Pivots
These shall generally conform to IS 1837. These shall be of mild steel or cast brass or Aluminum or as specified. The brass, fan light pivots shall be finished bright, chromium plated or as specified. M.S. fan light pivot shall be copper oxidized (black finish) or as specified. The base and socket plate of M.S. fan light pivots shall be made from minimum 3.0 mm M.S. sheet and the pivot shall be of round M.S. bar of minimum 10 mm diameter projecting out by minimum 12 mm length and firmly riveted to the base plate. The base and socket plate of cast brass fan light pivots shall be made from minimum 3.0 mm thick brass plate and the projected pivot shall not be less than 12 mm diameter and 12 mm length, cast in single piece with the base plate.

13.19 WHITE WASH WITH LIME
13.19.1 Scaffolding
All the specification shall be applicable as given in the chapter of wood work para 12.14.1.

13.19.2 Preparation of Surface
All the specification shall be applicable as given in the chapter of wood work para 12.14.2.

13.19.3 Preparation of Lime Wash
All the specification shall be applicable as given in the chapter of wood work para 12.14.3.
13.19.4 Application
All the specification shall be applicable as given in the chapter of wood work para 12.14.4.

13.19.5 Protective Measures
Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashings and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

13.19.6 Measurements
Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals. Measurements for Jambs, Soffits and Fills etc. for openings shall be as described in 12.1.9.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated asbestos cement sheet</td>
<td>20%</td>
</tr>
<tr>
<td>Semi corrugated asbestos cement</td>
<td>10%</td>
</tr>
</tbody>
</table>

Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements.

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared. Work on old treated surfaces shall be measured separately and so described.

13.19.7 Rate
The rate shall include all material and labour involved in all the operations described above.

13.20 DRY DISTEMPER
13.20.1 Materials
All the specification shall be applicable as given in the chapter of wood work para 12.18

13.20.2 Preparation of Surface
All the specification shall be applicable as given in the chapter of wood work para 12.18.1

13.20.3 Priming Coat
All the specification shall be applicable as given in the chapter of wood work para 12.18.2

13.20.4 Application
All the specification shall be applicable as given in the chapter of wood work para 12.18.3

13.20.5 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under in para 12.14.

13.21 OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING
13.21.1 Materials
All the specification shall be applicable as given in the chapter of wood work para 12.19.1

13.21.2 Preparation of the Surface
All the specification shall be applicable as given in the chapter of wood work para 12.19.2

13.21.3 Application
All the specification shall be applicable as given in the chapter of wood work para 12.19.3

13.21.4 The specifications in respect of scaffolding, protective measures and measurements and rate shall be as described under 12.14
13.22 CEMENT PAINT
13.22.1 Material
All the specification shall be applicable as given in the chapter of wood work para 12.21.1

13.22.2 Preparation of Surface
All the specification shall be applicable as given in the chapter of wood work para 12.21.2

13.22.3 Preparation of Mix
All the specification shall be applicable as given in the chapter of wood work para 12.21.3.

13.22.4 Application
All the specification shall be applicable as given in the chapter of wood work para 12.21.4.

13.22.5 Precaution
All the specification shall be applicable as given in the chapter of wood work para 12.21.3.

13.22.6 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under para 12.14. The coefficient for cement paint on RCC Jali shall be the same as provided in Sl. No. 7 of Table 12.1 para 12.23.6.

13.23 PAINTING READY MIXED PAINT OVER G.S. SHEETS
Ready mixed paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S. sheets shall be painted with a priming coat of one coat of red oxide zinc chromate paint.

13.23.1 Preparation of Surface
(a) Painting New Surface:
All the specification shall be applicable as given in the chapter of wood work para 12.27.1.

(b) Painting Old Surface: If the old paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with red lead. If the old paint is blistered and flaked, it shall be completely removed as described in para 12.41. Such removal shall be paid for separately and painting shall be treated as on new work.

13.23.2 Application
The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning. The second or additional coats shall be applied when the previous coat has dried.

13.23.3 The specifications described in para 12.23 shall be applicable.

13.24 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS
13.24.1 Material
The primer shall be prepared on site or shall be of approved brand and manufacture. Paint shall be anti-corrosive Bitumastic paint aluminum paint or other type of paint as specified in the description of the item.

13.24.2 Painting on New Surface
The surface shall be prepared for priming coat as described in para 12.24.2.2.

13.24.2.1 Application: The number of coat of painting over the priming coat shall be as stipulated in the description of the item. The application of paint over priming coat shall be carried out as specified in para 12.32.2.

13.24.2.2 Measurements: Measurements will be taken over the finished line of pipe including specials etc. in running meters; correct to a cm. Pipes of different diameters of bore shall be measured and paid for separately. Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.
13.24.2.3 **Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

13.24.2 Painting on Old Surface
The surface shall be prepared as specified in para 12.25.1.2.

13.24.2.1 The specifications for application shall be as described in para 12.25.2.

13.24.2.2 Measurements, rate and other details shall be as specified in para 12.23.6.

13.25 **PAINTING WITH WOOD PRESERVATIVE**
13.25.1 The oil type wood preservative of specified quality and approved make, conforming to IS 218 shall be used. Generally, it shall be creosote oil type-I or Anthracene oil.

13.25.2 Painting on New Surface
*Preparation of Surface:*
All the specification shall be applicable as given in the chapter of wood work para 12.27.1.(a).

13.25.2.2 **Application:**
All the specification shall be applicable as given in the chapter of wood work para 12.27.1.(b)

13.25.2.3 The other specifications described in para 12.23 they are applicable.

13.25.3 Painting on Old Surface
The work shall be done in the same manner as on new surface except that only one coat shall be done.

13.26 **WALL PAINTING WITH PLASTIC EMULSION PAINT**
The plastic emulsion paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These paints are to be used on internal surfaces except wooden and steel. Plastic emulsion paint as per IS 5411 of approved brand & manufacture & of the required shade shall be used.

13.26.1 Painting on New Surface
The wall surface shall be prepared as specified in para 12.31.

13.26.1.1 **Application:** The number of coats shall be as stipulated in the item. The paint will be applied in the usual manner with brush, spray or roller. The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces. The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer’s instructions.

The surface on finishing shall present a flat velvety smooth finish; more coats will be applied till the surface presents a uniform appearance if necessary.

13.26.1.2 **Precautions**
*Following precaution shall be taken:-*
(a) Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

(b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

(c) Old brushes if they are to be used with emulsion paints should be completely dried of turpentine or oil paints by washing in warm soap water. Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

(d) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
13.26.1.3 Other details shall be as specified in para 12.23 are applicable.

13.26.2 Painting on Old Surface
The surface shall be prepared as specified in para 12.31.2.1 except that the surface before application of paint shall be flattened well to get the proper flat velvety finish after painting. The application shall be as specified in para 12.31.2.2 except that thinning with water shall not normally be required. Other details shall be as specified in para 12.23 applicable.

13.27 PAINTING WITH ENAMEL PAINT
Enamel Paint (conforming to IS 2933) of approved brand and manufacture and of the required colour shall be used. For the undercoat, the paint of same quality but of shade to suit that of the top coat shall be used. Preparation of surface and application shall be as specified under para 12.32 for painting on new surfaces or old surfaces, as the case may be. Other details shall be as specified in para 12.23 are applicable.

13.28 PAINTING WITH SYNTHETIC ENAMEL PAINT
Synthetic enamel paint (conforming to IS 2932) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

13.28.1 Painting on New Surface
Preparation of surface shall be as specified in para 12.24.2 as the case may be.

13.28.2 Application:
All the specification shall be applicable as given in the chapter of wood work para 12.32.1.1.

13.28.3 Painting on Old Surface
All the specification shall be applicable as given in the chapter of wood work para 12.32.1.2.

13.28.4 Other details shall be as specified in para 12.23 are applicable.

13.29 PAINTING WITH ALUMINIUM PAINT
All the specification shall be applicable as given in the chapter of wood work para 12.33

13.29.1 Preparation of Surface
Steel Work (New Surfaces): All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust. C.G.S. Sheets (New Surfaces): The preparation of surface shall be as specified in para 12.25.1.1
Steel Work or C.G.S. Sheets (Old Surfaces): The specifications shall be as described in para 12.25.1.2.

13.29.2 Application
All the specification shall be applicable as given in the chapter of wood work para 12.33.2

13.29.3 Other detail shall be as specified in para 12.23 are applicable

13.30 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT
All the specification shall be applicable as given in the chapter of wood work para 12.35

13.31 VARNISHING
Ordinary copal varnish or superior quality spray varnish shall be used. It includes sizing of transparent wood filler.

13.31.1 Material
Varnish (conforming to IS 347) for the finishing and undercoats shall be of the approved manufacturer.

13.31.2 Varnishing on New Surfaces
13.31.2.1 Preparation of Surface:
All the specification shall be applicable as given in the chapter of wood work para 12.37.1.1
13.31.2.2 Sizing or Transparent Wood Filler Coat:
All the specification shall be applicable as given in the chapter of wood work para 12.37.1.2

13.31.2.3 Application of Varnish:
All the specification shall be applicable as given in the chapter of wood work para 12.37.1.3

13.31.2.4 Other details shall be as specified in 12.23 as far as they are applicable.

13.31.3 Varnishing on Old Surface
All the specification shall be applicable as given in the chapter of wood work para 12.37.2

13.32 LETTERING WITH PAINT
Black, Japan paints (conforming to IS 341) or ready mixed paint shall be of approved brand and manufacture, and ordinary ready mixed paint shall be of the shade required by the Engineer-in-Charge.

13.32.1 Lettering on New Surface
13.32.1.1 Application:
All the specification shall be applicable as given in the chapter of wood work para 12.40.1.1.

13.32.1.2 Measurements:
All the specification shall be applicable as given in the chapter of wood work para 12.40.1.2.

13.32.1.3 Rate:
All the specification shall be applicable as given in the chapter of wood work para 12.40.1.3.

13.32.2 Relentering on Old Surface
Painting shall be done over the existing letters and shall accurately follow their lines and curves. One or more coat of paints shall be applied till a uniform colour and glossy finish is obtained. Measurements and Rate shall be as specified under 12.40.2.

13.33 DOUBLE SCAFFOLDING
Specifications are same as described in sub head RCC work.
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14.0 DISMANTLING AND DEMOLISHING
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14 Definitions
(i) Dismantling: - Dismantling means carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the building as specified or shown on the drawings.

(ii) Demolition: - It means breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on the drawings.

14.1 GENERAL
This chapter relates to buildings only.

14.1.1 Precautions
(i) All materials obtained from dismantling or demolition shall be the property of the local body unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer-in-Charge or authorized representative.

(ii) Before starting the work, the first operations shall be got approved from the Engineer-in-Charge. The demolition shall always be well planned before hand and shall generally be done in reverse order of the one in which the structure was constructed.

(iii) Special care shall be taken to maintain the safety measures prescribed in IS 4130. Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up. The work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions and necessary scaffolding with suitable double scaffolding and proper cloth covering shall also be provided. Necessary precautions shall be taken to keep noise and dust nuisance to the minimum, Helmets, goggle, safety belts etc all work shall be done in a systematic manner in the direction of the Engineering in charge

(iv) All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Chisels and outers may be used carefully and dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then property stacked as per direction of the Engineer-in-Charge.

(v) Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.

(vi) Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly within a lead of 50 meters and unserviceable materials, rubbish etc. shall be disposed off or as directed by the Engineer-in-Charge.

(vii) The Dismantling and demolishing work should be carried out at night. Screens shall be placed where necessary to prevent injuries due to falling pieces. First-aid equipment shall be got available at all demolition works site.

(viii) The contractor shall maintain/disconnect existing services, whether temporary or permanent, where required by the Engineer-in-Charge.

(ix) Water may be used to reduce dust while tearing down plaster from brick work.

(x) Safety belts shall be used by labourers while working at higher level to prevent falling from the structure.

14.2 RECOMMENDATIONS FOR DEMOLITION OF CERTAIN SPECIAL TYPES AND ELEMENTS OF STRUCTURES
14.2.1 Roof Trusses
When a building has a pitched roof, the roof structure should be removed to wall plate level by hand method. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts. On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.
14.2.2 Heavy Floor Beams
The heavy bulks of timber and steel beams should be supported before cutting at the extremities and should then be lowered to a safe working place.

14.2.3 Jack Arches
If tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. Particular care should be exercised and full examination of this type of structure undertaken before demolition is commenced. The floor should be demolished in strips parallel to the span of the arch, rings (at right angles to the main floor beams).

14.2.4 Brick Arches
14.2.4.1 The expert advice should be obtained and at all stages of the demolition, the closest supervision should be given by persons fully experienced and conversant in the type of work to ensure that the structure is stable at all times. Special temporary support shall be provided in the case of skew bridges.

14.2.4.2 Maximum dead load as possible may be removed provided it does not interfere with the stability of the main arch rings but it should be noted that the load-carrying capacity of many old arches relies on the filling between the spandrels. On no account should the restraining influence of the abutments be removed before the dead load of the spandrel fill and the arch rings are removed.

14.2.4.3 A single span arch can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch until the width of the arch has been reduced to a minimum which can then be collapsed.

14.2.4.4 If it is impossible to allow debris to fall to the ground below, centering designed to carry the load should be erected and the arch demolished progressively. The design of the centering should make appropriate allowance for impact.

14.2.4.5 If deliberate collapse is feasible the crown may be broken by the demolition ball method working progressively from edges to the centre. Collapse of the structure can be affected in one action by the use of explosives. Charges should be inserted into boreholes drilled in both arch and abutments.

14.2.4.5 In multi-span arches before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for a single span, care being taken to demolish the spandrels down to the springing line as the work proceeds. Where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portions standing.

14.2.6 Cantilevers
A cantilever type of construction depends for its stability on the super imposed structure. Canopies, cornices, staircases and balconies should be demolished or supported before the tailing down load is removed.

14.2.7 In-situ Reinforced Concrete
14.2.7.1 Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.

14.2.7.2 Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.

14.2.7.3 Demolition should be commenced by removing partitions and external non-load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.

14.2.7.4 The following procedures should be used in hard demolition methods are to be used:-

(A) Reinforced Concrete Beams
For beams, a supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be
cut in such a way as to allow the beam to be lowered under control to the floor.

(B) **Reinforced Concrete Columns**
For columns, the reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control.

(C) **Reinforced Concrete Walls**
Reinforced concrete walls should be cut into strips and demolished as for columns.

14.3 **MEASUREMENTS**:- For measurement shall be given below procedure
14.3.1 All work shall be measured correct to a cm, all area shall be worked out in sqm, correct to two places of decimal and cubical content shall be worked out to the nearest 0.01 cum.

14.3.2 The dismantling and demolishing shall be measured separately.

14.3.3 All work except hidden work shall be measured before demolition or dismantling and no bulking allowance shall be allowed.

14.3.4 The specifications for deduction for voids, and openings etc. shall be on the same basis as that adopted for new construction of the work.

14.3.5 The work executed in under water/ liquid mud and in under all foul position shall be measured separately.

14.3.6 Roofs
(i) Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supports shall be measured in sqm. Except lead sheet roof covering which shall be measured in quintals.

(ii) Stone slab roof covering which shall be measured in cubic meters.

(iii) Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed.

(iv) Mud phuska on roofs shall be measured in cubic meters.

(v) Lead sheets in roofs shall be measured in quintals and hips, valleys, flashings; lining to gutter etc. shall be included in this weight.

(vi) R.B. or R.C.C. roofs shall be measured as specified in 14.3.11.

(vii) Supporting members, such as rafters, purlins, beam Joists, trusses etc. of wood shall be measured in cubic meters and steel or iron sections, in quintals.

14.3.7 Ceiling
(i) The stripping of ceilings shall be measured in square meters.
(ii) Dismantling of supporting Joists, beams, etc. shall be measured in cubic meters or in quintals.
(iii) Height above floor level, if it exceeds 3.5 m shall be paid separately.

14.3.8 Flooring and Paving’s
Dismantling of floors (except concrete and brick floors) shall be measured in square meters. Supports such as joints, beams etc. if any shall be measured in cum. Concrete and bricks paving shall be measured in cum.

14.3.9 Concrete and Brick Roofs and Suspended Floors
Demolition of floors and roofs of concrete or brick shall be measured in cubic meters. Beams cantilevers or other subsidiary supports of similar materials, shall be included in the item. In measuring thickness of roofs provide with water proofing treatments with bitumen felts, the thickness of water proofing treatment shall be ignored.
14.3.10 Walls and Piers
(i) Taking down walls and independent piers or columns of brick, stone or concrete shall be measured, in cubic meters. All copings, corbels, cornices and other projections shall be included with the wall measurements.

(ii) In measuring thickness of plastered walls, the thickness of plaster shall be ignored.

(iii) Ashlar face stones, dressed stone work, pre-cast concrete articles etc, if required to be taken down intact shall be so stated and measured separately in cubic meters.

(iv) Cleaning bricks stacking for measurements including all extra handling and removal and Disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

(v) Cleaning stone obtained from demolished/dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and pre-cast concrete blocks including all extra handling and disposing off the rubbish as stated shall be measured in cubic meters of cleaned stone.

(vi) Honey comb works or cavity walls of bricks stone or concrete shall be measured as solid.

14.3.11 Reinforced Concrete and Brick Work
Reinforced concrete structures and reinforced brick roofs and walls shall be measured in cubic meters and if reinforcement is required to be salvaged, it shall be so stated.

Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in quintal of salvaged steel.

14.3.12 Partitions, Trellis Work etc.
Partitions or light walls, of lath and plaster, trellis work, expanded metal, thin concrete or terracotta slabs and other similar materials including frame work if any shall be measured in square metros stating the over all thickness.

14.3.13 Woodwork
All wood work including karries average 40 sq cm or over in section, shall be measured in cubic metros, while that under 40 sq cm in section, in running meters. Ballies shall be measured in running meters. Boarding including wooden chajjas and sun shades along with supports shall be measured in square meters in its plane.

14.3.14 Doors and Windows
Dismantling of doors, windows, clerestory windows, ventilators etc. (wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, holdfats and other attachments. If only shutters are to be taken out it shall be measured separately.

14.3.15 Steel and Iron Work
(i) All steel and iron work shall be measured in quintals. The weight shall be computed from standard tables unless the actual weight can readily be determined.

(ii) Riveted work, where rivets are required to be cut, shall be measured separately.

(iii) Marking of structural steel required to be re-erected shall be measured separately.

(iv) In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

14.3.16 Pipes and Sewer Lines
(i) Water pipe lines including rain water pipes with damps and specials, sewer lines (salt glazed ware or concrete) etc. shall be described by their diameter and length measured in running meters inclusive of joints.
(ii) If the joints, special and fittings etc are required to be separated, it shall be so stated and enumerated.

(iii) Pacca drains shall be measured under relevant items.

(iv) Valve cistern, public fountain platform, fire hydrants, etc. shall be enumerated.

(v) Manholes and inspection chambers shall be enumerated stating the size and depth of manhole/inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one meter depth. The depth of the manhole shall be the distance between the top of manhole cover and invert level of the drain.

(vi) Ventilating shafts, gully traps, flushing cisterns and other appurtenant items of work shall be enumerated.

14.3.17 Posts or Struts
Posts or struts (wood, steel or RCC) section including taking out embedded portion shall be measured in running meters.

14.3.18 Wire Mesh fencing of any type with frame shall be measured in square meters,

14.3.19 Glazing
Taking out any portion of serviceable glass except polished plate, from old sashes, skylights, etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square meters. Irregular circular panes shall be measured as rectangle or square enveloping the same. The width and height being measured correct to the nearest 0.5 cm.

14.3.20 In road work different types of road surfaces shall be measured separately. Road surfaces metalling or soling (base) shall be measured in sqm, while concrete paving shall be measured in cum.

14.4 RATES
The rate shall include the cost of all labour involved and tools used in dismantling and demolishing including scaffolding. The rate shall also include the charges for separating out and, stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 meters.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.
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15.0 PILE WORK
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<td>Load test on piles, Types of loadings/Test-vertical load test, preparation of pile head, Loading platform, Application of load, Maintained load method, Measurement, Rate, Cyclic vertical load testing, General, Preparatory pile head, loading platform, Application of load, Test procedure and it’s analysis, measurement and Rate.</td>
</tr>
<tr>
<td>15.5.4 to 15.5.4.6</td>
<td>Lateral load testing, load platform, Application of load, Displacements, measurement and rate.</td>
</tr>
<tr>
<td></td>
<td>List of Bureau of Indian Standard Codes.</td>
</tr>
</tbody>
</table>
15.0 General:
The term pile foundation is used to describes a construction for the foundation of a wall or a pier, which in turn is supported on the piles. The piles may be placed separately or they may be placed in the form of a cluster through the length of the wall this construction is adopted when loose soil extends to a great depth. The load of the structure is transmitted by the piles to hard stratum below or it is resisted by the friction developed on the sides of the pile. In this chapter various aspects associated with the pile foundation will be discussed.

15-(A)Definitions:-
Allowable Load: It is load which is applied to a pile after taking into account its ultimate load capacity, pile spacing, Overall bearing capacity of the ground, the allowable settlement, negative skin friction including reversal of loads.

Bearing Pile: A pile formed in the ground for transmitting load of a structure to the soil by the resistance developed at its tips and or along its surface, it is either vertical or batter pile. It may be ‘End bearing pile’ or friction pile if it supports the load primarily along the surface.

Bored Compaction Pile: It is bored cast-in-situ with or without bulb. In this compaction of surrounding ground and freshly filled concrete in pile, bore is simultaneously achieved by suitable method. A pile with a bulb is called a "under-reamed bored compaction pile". Under-reamed pile with more than one bulb is called Multi-under-reamed pile.

Constant Rate of Penetration (CRP) Test: The ultimate bearing capacity of preliminary piles and piles which are not used as working piles.

Constant Rate of Uplift (CRU) Test: The ultimate capacity in tension of preliminary piles and piles which are not used as working piles.

Cut off Level: It is the level where the installed pile is cut off to support the pile caps or beams.

Datum Bar: A rigid bar placed on immovable supports.

Draft Bolt: A metal rod driven into hole bored in timber, the hole being smaller in diameter than the rod.

Drop of Stroke: The distance through which the driving weight is allowed to fall for driving the piles.

Factor of Safety: It is the ratio of the ultimate load capacity of a pile to the safe load of a pile.

Follower Tube: A tube which is used following the main casing tube and it requires to be extended further. The inner diameter of the follower tube should be the same as the inner diameter of casing. The follower tube shall preferably be an outside guide and should be water tight when driven in water-bearing strata or soft clays.

Initial Test: This test is carried out with a view to determine ultimate load capacity and safe load capacity.

Raker or Batter Pile: The pile which is installed at an angle to the vertical. Raker piles are normally provided where vertical piles cannot resist the required applied horizontal forces. The maximum rake to be permitted in piles shall not exceed.

1 in 8 for cast-in-situ piles of large diameter-viz. 750 mm dia., And above.
1 in 5 for smaller dia. cast-on-situ piles.
1 in 4 pre-cast piles.

Routine Test: It is carried out with a view to check whether pile is capable of taking the working load assigned to it.

Safe Load: It is the load arrived at by applying a factor of safety to the ultimate load capacity of the pile.

Set: The net distance by which the pile penetrates in the ground due to stated number of blows of the hammer.
**Spliced Pile:** A pile composed of two or more lengths secured together, end to end to form one pile.

**Test Pile:** A pile which is selected for load testing and which is subsequently loaded for that purpose. This pile may form working pile itself if subjected to a routine load test with up to one and half time the safe load.

**Total displacement (Gross):** The total movement of the pile under a given load.

**Total Elastic Displacement:** This is the magnitude of the displacement of the pile due to rebound caused at the top after removal of given test load. The components of total elastic displacements are as below:-

(a) Elastic displacement of the soil participating in load transfer; (b) Elastic displacement of the pile shaft.

**Trial Piles:** These are installed initially to assess the load carrying capacity, it is either tested to ultimate bearing capacity or twice the estimated safe load.

**Ultimate Load Capacity:** The maximum load which a pile can carry before failure of ground (when the soil fails by shear) or failure of pile materials.

**Working Load:** It is a load assigned to a pile as per design.

**Working Pile:** It is a pile forming part of foundation of a structural system.

**15-(B) Uses Of Piles:**
The situation which demand piles as foundation are as follows:

1. The load coming from the structure is very heavy and the distribution of load on soil is uneven.
2. The subsoil water level is likely to rise or fall appreciably. This may be seasonal or occasional variation.
3. The pumping of subsoil water is too costly for keeping the foundation trench in dry condition.
4. The construction of raft or grillage foundations is likely to be very expensive or is practically impossible.
5. The firm bearing stratum exists at a greater depth. The piles up to 20 meters depth are common and under exceptional circumstances, they may even be taken to 30 meters depth. The circumstances, they may even be taken to 30 meters depth. The piles are considered to be long when their length exceeds 30 meters.
6. The timbering to excavations is too difficult to maintain the sides of the foundation trench.
7. The pile foundation is to be adopted for the structures in the area where canals, deep drainages line, etc. are to be constructed in near future.

**15.1 DRIVEN CAST-IN-SITU REINFORCED CEMENT CONCRETE PILES**
Cast-in-situ piles shall be installed by driving a metal casing with a shoe at the tip and displacing the material laterally. Driven cast-in-situ pile is formed by driving a casing, permanent or temporary and subsequently filling the hole with plain or reinforced concrete.

**15.1.1 Equipment**
The equipment and accessories used for driven cast-in-situ piles shall depend on type of sub-soil strata, ground water conditions, type of founding material and penetration etc. Commonly used plants as given below and few more are as below:

**Dolly:** A cushion of hardwood or some suitable material placed on the top of the casing to receive the blows of the hammer

**Kent Ledge:** Dead weight used for applying a test load to a pile.

**Shoe:** Pile Shoe should be of material as specified in the item. The pile shoes may be either cast iron or mild steel. Cast iron pile shoes shall be made from chill hardened iron as used for making grey iron
casting confirming to IS 210, the chilled iron point shall be free from blow holes and other surface defects. Cast steel piles shoe shall be of steel conforming to IS 2644. Straps or other fastenings to cast pile shoes shall be of steel conforming to IS 1079 and shall be cast into the point to form an integral part of shoe. Different types of pile shoes are shown in Fig. 15.1

![Square Pile Shoe](image1)
![Round Pile Shoe](image2)
![Pile Shoe with Wedge Shape](image3)

**Fig. 15.1: Different Types of Pile Shoes**

**Drop Hammer (or Monkey):** Hammer, ram or monkey raised by a winch and allowed to fall under gravity.

**Single or Double Acting Hammer:** A hammer operated by steam compressed air or internal combustion, the energy of its blows being derived mainly from source of motive power and not from gravity along.

**Pile Frame (or Pile Rig):** A movable steel structure for driving piles in the correct position and alignment by means of a hammer operating in the guides or (leaders) of the frame.

**Pile driving hammer Scope**

Driving Hammer of standard weight and strokes of different types shall be used.

The object should be to keep weights of hammers to a limited range and standardize weight interval and stroke to facilitate their use with piling rig & piling attachments of different plants.

Piles may be driven with any type of hammer, provided they penetrate to the prescribed depth or attain to ensure a final penetration of not more than 5 mm per blow.

**Classification**

It is preferable to employ the heaviest hammer practicable and to limit the stroke, so as not to damage the pile. Pile hammers shall be classified as given in the Table below:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Class</th>
<th>Weight Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Light Hammers</td>
<td>Up to 500</td>
</tr>
<tr>
<td>(ii)</td>
<td>Medium Hammers</td>
<td>Over 500 and up to 2500</td>
</tr>
<tr>
<td>(iii)</td>
<td>Heavy Hammers</td>
<td>Over 2500</td>
</tr>
</tbody>
</table>

**Sizes**

The recommended sizes (weight of ram or striking part) and stroke of different types shall be as Given in Table below:-
S. No. | Type of Hammers | Light (up to 500 Kg) | Medium (over 500 up to 2500 Kg) | Heavy (over 2500 Kg)
---|---|---|---|---
1 | Drop Hammer | 250 to 500 kg at multiples of 125 kg | 750 to 2500 kg at multiples of 250 kg | 2750 to 4500 kg at multiples of 250 kg
2 | Single acting capable of working on steam or air at 5.5 kg/cm² at the hammer (a) 25 to 100 kg at multiples of 25 kg at maximum stroke of 20 cm (b) 100 to 500 kg at multiples of 100 kg at maximum stroke of 40 cm. | 750 to 2500 kg at multiples of 250, at maximum stroke of 90 cm. | 3000 to 7500 kg at multiples of 500 kg at maximum stroke at 120 cm.
3 | Double acting capable of working on steam or air at 5.5 kg/cm² at the hammer (a) 25 to 100 kg at multiples of 25 kg at maximum stroke of 20 cm (b) 100 to 500 kg at multiples of 100 kg at maximum stroke of 25 cm. | 750 to 2500 kg at multiples of 500, at maximum stroke of 45 cm. | 
4 | Diesel Hammer | 500 kg at maximum stroke of 250 cm | Over 500 up to 2500 kg at multiples of 500 kg at maximum stroke of 250 cm. | 

15.1.2 Pile Driving
15.1.2.1 Installation of Piles: Installation of piles shall be as accurate as possible and as per design and drawings. The vertically or the required batter should be correctly maintained. Particular care shall be taken in respect of installing either single pile or piles in two pile groups.

15.1.2.2 Tolerance
(i) The deviation/tolerance should be as per IS 2911 (Part 1/Sec.1). The piles should not deviate more than 75 mm or D/4 whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from their desired position at the working level.

(ii) In case of a single pile under a column, the positional deviation should not be more than 50 mm or D/4 whichever is less (100 mm in case of piles having diameter more than 600 mm. Greater tolerance may be prescribed for piles driven over water and for raking piles.

15.1.2.3 Sequence of Installation: Normal sequence of installation of pile group is from the centre to the periphery of the group or from one side to the other. Particular care shall be taken to avoid damaging the already cast pile while driving a fresh tube nearby before the concrete has sufficiently set. The possibility of the pile getting damaged is more in compact soils than in loose soils.

15.1.2.4 Driving a Group of Friction Piles
(i) The skin friction increases considerably when the pile bore is driven in the loose sand as the pile tends to compact the sand. Therefore in such cases the order of installation shall be altered so that a compact block is not created where driving further pile bore will not be possible. Similar precaution will have to be taken where stiff clay or compact sand layers will have to be penetrated.

(ii) However driving the pile bore from centre outwards or commencing at a particular selected edge or even working across the group the problem pointed out in Para (i) above can be avoided.

(iii) In case of very soft soil it is advisable to start driving the bore hole from outside to inside so that the soil gets restrained from flowing out during operation.

15.1.2.5 Procedure of Pile Driving
(i) Driven cast-in-situ concrete piles are installed by driving a metal casing with a shoe at the tip/toe and displacing the material laterally.

(ii) These piles may be cast in metal shells which may remain permanently in place or the casing may be withdrawn which may be termed as uncased driven cast-in-situ cement concrete piles.
(iii) The metal casing shall be of sufficient thickness and strength to hold in original form and show no harmful distortion when the adjacent casing is driven and the driving core if any is withdrawn.

(iv) Driven cast-in-situ concrete piles shall be installed using a property designed detachable shoe at the bottom of the casing.

(v) Any liner or bore hole; which is temporarily located and shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Engineer-in-Charge.

15.1.2.6 A proper record of pile driving and other details such as depth driven, sequence of installation in a group, cut off level/working level shall be mentioned in sequence of occurrence worksheet for the inspection of Engineer-in-charge.

15.1.3 Jetting
(i) Driving of pile may be assisted by preparing holes or by the use of jets or both subject to the approval of the Engineer-in-charge- These may be used essentially to achieve the minimum penetration shown on the drawings where such penetration is not reached under normal conditions of driving. The diameter of the hole shall; not be greater than the diagonal dimension of the pile less 100 mm.

(ii) The maximum depth of the preboring shall be such that the specified set (or less) is obtained when the toe of the pile is at founding level. Preboring shall be as approved by the Engineer-in-charge and shall not extend beyond one meter above the founding level and the pile shall be driven to at least one meter below the prebored hole. To ensure that the pile is properly supported laterally in the hole, any space remaining around the pile at the ground level after driving is finished shall be backfilled with approved granular material.

(iii) When the water jetting is used at least two jets shall be attached to the pile symmetrically. The volume and pressure of water at the outlet nozzles shall be sufficient to freely erode material adjacent to the toe of the pile. The maximum depth of jetting shall be such that the specified set is obtained when the toe of the pile is at founding level. Jetting shall cease as directed by the Engineer-in-Charge and shall not proceed beyond one meter above the founding level and the pile shall be driven at least one meter below the prebored hole.

(iv) To avoid very hard driving and vibration in materials such as sand, jetting of piles by means of water may be carried out in such a manner as not to impair the bearing capacity of piles already in place, the stability of the soil or the safety of any adjoining buildings. Details of arrangement for jetting shall be got approved from the Engineer-in-Charge in advance.

(v) If large quantities of water are used for jetting it may be necessary to make provision for collection of water when it comes to the ground surface so that the stability of the piling plant is not endangered by the softening of the ground. Jetting shall be stopped before completing the driving which shall always be finished by ordinary methods. Jetting shall be stopped if there is any tendency for the pile tips to be drawn towards the pile already driven owing to the disturbance to the ground.

15.1.4 Reinforcement
(i) The design of reinforcing cage varies depending upon the driving and installation conditions, the nature of the sub-soil and the nature of load to be transmitted by the shaft, axial or otherwise. The minimum area of longitudinal reinforcement of any type or grade within the pile shaft shall be 0.4% of the sectional area calculated on the basis of the outside area of the casings of the shaft.

(ii) The curtailment of reinforcement along the depth of the pile, in general, depends on the type of loading and sub-soil strata, in case of piles subjected to compressive load only, the designed quantity of reinforcement may be curtailed at appropriate level according to design requirements. For piles subjected to uplift load, lateral load & moments, separately or with compressive loads, it may be necessary to provide reinforcement to the full depth of the pile. In soft clays or loose sands, or where there is likelihood of danger to green concrete due to driving of adjacent piles, the reinforcement should be provided up to full pile depth, regardless of whether or not it is required from uplift & lateral load considerations. However, in all cases, the minimum reinforcement specified in Para (i) above should be provided in full length of the pile.
(iii) Piles shall always be reinforced with a minimum amount of reinforcement as dowels keeping the minimum bond length into the pile shaft below its cut-off level, and with adequate projection into the pile cap, irrespective of design requirements.

Note: In some cases the cage may lift at bottom or at the laps during withdrawal of casing. This can be minimized by making the reinforcement "U" shaped at the bottom and up to well secured joints. Also the lifting 5% of the length should be considered not to affect the quality of pile.

(iv) Clear cover to all main reinforcement in pile shaft shall be not less than 50 mm and shall be maintained by suitable spacers. The laterals of reinforcing cage may be in the form of links or spirals. The diameter and spacing of the same is chosen to impart adequate rigidity of the reinforcing cage during the handing and installation. The minimum diameter of links or spirals shall be 6 mm and the spacing of the links or spirals shall be not less than 150 mm. The minimum clear distance between two adjacent main reinforcement should normally be 100 mm for full depth of the cage.

(v) The reinforcing cage should be left with adequate protruding length above the cut off level for proper embedment in the pile cap. Prior to the lowering of reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials.

(vi) Reinforcement in the form of cage shall be assembled with additional support, such as spreader forks and lacings, necessary to form a rigid cage hoops, links, or helical reinforcement has to fit closely around the main longitudinal bars and shall be tied by binding wire of approved quality. The ends of the binding wire shall be turned into the interior of the pile. Reinforcement shall be placed and maintained in correct position. The reinforcements shall be joined wherever necessary by welding and the procedure of welding be followed as described in IS 2751.

15.1.5 Concrete
1) **Cement**: Cement shall be as specified in agreement item or as specified under sub-head 2.0 Chapter for mortar. However, high alumina cement shall not be used.

2) **Water**: Water to be used for concreting shall be as specified under sub-head 2.0 of Specifications.

3) **Fine Aggregate**: Fine aggregate to be used for concreting shall be as specified under subhead 2.0 of Specifications.

4) **Coarse Aggregate**: For tremie concreting, coarse aggregate having nominal size more than 20 mm should not be used. Natural rounded shingle of appropriate size may also be used as coarse aggregate. It helps to give high slump with less water cement ratio-

5) **Chemical Admixtures**: Admixtures to be used in the concrete shall be as per IS 9103.

6) **Concrete Grades to be adopted**
   (i) Concreting of piles shall be done only with design mix of appropriate grade with weigh batching of constituents. The grade of concrete to be kept as per nomenclature of the item.

   (ii) Only concrete Grade M-25 and/or higher grades shall be used for concreting the piles. The exact grade of concrete to be used shall mainly depend upon the nature of work and the general design consideration. However, Concrete Grade M-15 and Grade M-20 shall not be used for concreting piles under any circumstances, even with weigh batching. The minimum cement content shall be 400 kg/m³ in all conditions.

   (iii) When concreting under water or drilling mud 10% additional cement over the minimum cement content for the particular grade shall be used subject to a minimum cement content of 370 kg/cum.

7) **Workability of Concrete**: The minimum slump shall be 100 mm when the concrete for the piles is being vibrated and when the concrete is not vibrated the maximum permitted slump is 150 mm. The degree of workability in both the cases is considered as very high.

8) **Placing of Concrete**
   (i) Before commencement of pouring of concrete, it shall be ensured that there is no ingress of water in the casing tubes from bottom. Further, adequate control during withdrawal of the casing tube is
essential so as to maintain sufficient head of concrete inside the casing tube at all stages of withdrawal.

(ii) Wherever practicable concrete should be placed in a clean dry hole where concrete is placed in dry hole and when casing is present, the top 3 m pile shall be compacted using internal vibrators. The concrete should invariably be poured through a tremie, with a funnel so that the flow is directed and concrete can be deposited in the hole without segregation. Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.

(iii) Where the casing is withdrawn from cohesive soils for the formation of cast-in-situ pile, the concreting should be done with necessary precautions to minimize the softening of the soil by excess water. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be allowed to be withdrawn.

(iv) The concrete shall be self compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silt clays and other soils with tendency to squeeze into newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or wager into concrete. The placing of concrete shall be continuous process from the toe level to the top of pile to prevent segregation, a tube of tremie pipe as appropriate shall be used to place concrete in all piles. To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.

(v) The diameter of the finished pile shall not be less than specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the length of pile cast. After each pile has been cast and any empty pile hole remaining shall be protected and back filled as soon as possible with approved material.

(vi) The minimum embedment of cast-in-situ concrete piles into pile cap shall be 150 mm. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete. The clear cover between the bottom reinforcement in pile cap from top of pile shall not be less than 30 mm. The reinforcement in the pile shall be exposed for full anchorage length to prevent the concrete around the pipe from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for each displacement of the partly set concrete. If the concreting cannot be resumed before final set of concrete already laid, the pile so cast may be rejected.

(vii) Normally concreting of piles should be uninterrupted. In exceptional case of interruption of concreting, but which can be resumed within 1 or 2 hours, the tremie shall not be taken out of the concrete. Instead it shall be raised and lowered slowly from time to time to prevent the concrete around the pipe from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for each displacement of the partly set concrete. If the concreting cannot be resumed before final set of concrete already laid, the pile so cast may be rejected.

(viii) In case of withdrawal of tremie out of concrete, either accidentally or to removed a choke in the tremie, may be re-introduced to prevent impregnation of laitance scum lying on the top of the concrete already deposited in the bore. The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug should be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm should be filled in the tremie which will push the plug forward and swill emerges out of the tremie displacing the laitance/scum. The tremie will be pushed further in steps masking fresh concrete sweep away laitance scum in its way. When the tremie is buried by about 60 to 100 cms, concreting may be resumed.

(ix) The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

(x) Where cut-off level is less than 1.5 meters below the working level concrete shall be cast to a minimum of 300 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile. When concrete is placed by tremie method concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one meter above cut off level. In the circumstances where cut-off level is below ground
water level the need to maintain pressure on the unset concrete equal to or greater than water pressure should be observed and accordingly length of extra concrete above cut-off level shall be determined.

9) Placing Concrete under Water

(i) Before concreting under water, the bottom of the hole shall be cleared of drilling mud and all soft loose materials very carefully. In case a hole is bored with use of drilling mud, concreting should not be taken up when the specific gravity of bottom slurry is more than 1.2. The drilling mud should be maintained at 1.5 m above the ground water level. Concreting under water for cast-in-situ concrete piles may be done either with the use of tremie method or by the use of approved method specially designed to permit under water placement of concrete.

General requirements and precautions for concreting under water are as follows:-

(a) The concreting of pile must be completed in one continuous operation. Also for bored holes, the finishing of the bore, cleaning of the bore, lowering of reinforcement cage and concreting of pile for full length must be accomplished in one continuous operation without any stoppage.

(b) The concrete should be coherent, rich in cement with high slump & restricted water cement ratio.

(c) The tremie pipe will have to be large-enough with due regard to the size of the aggregate. For 30 mm aggregate the tremie pipe should be of diameter not less than 150 mm and for larger aggregate, larger diameter of tremie pipe may be necessary.

(d) The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of water and concrete.

(e) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

(f) The pile should be concentrated wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the laitance from being entrapped within the pile.

(g) All tremie tubes should be scrupulously cleaned after use. When concreting is carried out under water a temporary casing should be installed to the full depth of the bore hole or 2 m into non collapsible stratum, so that fragments of ground cannot drop from the sides of the hole into the concrete as it is placed. The temporary casing may not be required except near the top when concreting under drilling mud.

15.1.6 Testing of Concrete

1) The concrete for the piles shall be sampled in accordance with the norms specified in IS 456. The frequency of sampling is given in Table 15.1.

<table>
<thead>
<tr>
<th>Quantity of Concrete in the Work m³</th>
<th>Number of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 5</td>
<td>1</td>
</tr>
<tr>
<td>6 - 15</td>
<td>2</td>
</tr>
<tr>
<td>16 - 30</td>
<td>3</td>
</tr>
<tr>
<td>31 - 50</td>
<td>4</td>
</tr>
<tr>
<td>51 and above</td>
<td>4 plus one additional sample for each additional 50m³ or part thereof.</td>
</tr>
</tbody>
</table>

Notes:

(i) At least one sample shall be taken from each shift.
(ii) Where concrete is produced as continuous production unit, such as ready mix concrete plant. The frequency of sampling may be agreed upon mutually by suppliers and purchasers.
2) **Test Specimen:** Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or to determine the duration of curing, or check the testing error, additional sample may as be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.

3) **Test Results of Samples:** The test results of the samples shall be the average of the strength of three specimens. The individual variation should not be more than ±15% of the average strength. If the variation is more, the test result of the sample is invalid.

### 15.1.7 Curing
As per IS 456 - 2000, exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 10 days from the date of placing concrete. The period of curing shall not be less than 14 days for concrete exposed to dry and hot weather conditions.

### 15.1.8 Defective Pile
(i) In case defective piles are formed they shall be removed or left in place whichever is convenient without affecting performance of the adjacent piles or cap as a whole. Additional piles shall be provided to replace them as directed.

(ii) Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before concreting of the pile cap and plinth beam, if the deviations are beyond permissible limit.

(iii) During chipping of the pile, top manual chipping may be permitted after three days of pile casting pneumatic tools for chipping shall not be used before seven days after pile casting.

(iv) After concreting the actual quantity of concrete shall be compared with average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

### 15.1.9 Ready Mix Concrete (RMC)
Alternatively, the contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of Engineer-in-Charge, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under clause 15.1.6 or alternatively he can propose his own sampling and testing procedure which should in turn be approved by the Engineer-in-Charge. Normally, RMC supplied to site are mixed with certain admixtures which enables the concrete to be used within 3 hours of supply at site. In case RMC supplied is not consumed within 3 hours of supply the quantity J3f RMC remaining unused beyond 3 hours shall be rejected and removed from site.

### 15.1.10 Measurement
Dimension shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured from top of shoe to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools and equipment for excavating driving etc.

### 15.1.11 Rate
The rate includes the cost of materials and labour involved in all the operations described above including pile embedded in pile cap, except soil investigation, reinforcement, pile cap and grade beam.

### 15.2 BORED CAST-IN-SITU REINFORCED CONCRETE PILES
The piles are formed within the ground by excavating or boring a pile within it with or without the use of temporary casing and subsequent filling it with plain or reinforced concrete. When the casing is left permanently it is termed as cased pile and when the casing is taken out it is termed as uncased pile.
15.2.1 Equipment
The equipment and accessories used for bored cast-in-situ piles shall on subsoil strata, ground water conditions, type of founding material and penetration etc.

The equipment is applicable for bored piles without the use of Bentonite.

General requirements of boring equipment are as below:-

Scope
Specification for pile boring equipment shall be as per IS 14362. Constructions of bored piles require careful selection of boring equipment. Choice of appropriate equipment will depend upon subsoil conditions, diameter of pile, their depths and other specific requirements of any particular work. Details of equipment and proposed methods of driving the pile shall be submitted by the tendered for scrutiny and approval by the competent authority.

Equipment described herein refers to construction of bored piles on land and without the use of Bentonite. The standard nominal diameter of piles shall be 450 mm, 500 mm, 600 mm and the like.

Materials
All materials used in the construction of pile boring equipment shall conform to the requirement of relevant Indian Standard IS 800 "Code of Practice" for general construction in steel.

Pile Boring Equipment :-
The various items comprising pile boring equipment are:
(a) Winch
(b) Derrick
(c) Boring/chiseling tools
(d) Temporary casings
(e) Tremie arrangements, and
(f) Accessories

15.2.1.1 Boring operation shall be done by rotary percussion type drilling rigs using direct mud Bentonite suspension circulation or reverse mud circulation methods to bail out the cuttings or as specified, in soft clays and loose sand, bailer and chisel method should be used with caution to avoid the effect of suction. Rope operated grabbing tool Kelly mounted hydraulically operated grab are also used. This method of advancing the hole avoids suction. The size of cutting tool shall be as per [IS 2911 (Part I Section 2)] and not less than the diameter of pile by more than 75 mm.

15.2.1.2 Use of drilling mud is stabilizing sides of bore whole where specified shall have properties as defined below:-

BASIC PROPERTIES OF DRILLING MUD (BENTONITE)

(A) Property:-
The bentonite suspension used in bore holes is basically clay of montmorillonite group having exchangeable sodium cat ions. Because of the presence of sodium cat-ions, bentonite on dispersion will break down into small plate like particles having a negative charge on the surfaces and positive charge on the edges. When the dispersion is left to stand undisturbed, the particles become oriented building up a mechanical structure at its own. This mechanical structure held by electrical bond is observable as a Jelly like mass or jell material. When jelly is agitated, the weak electrical bonds are broken and the dispersion becomes fluid.

(B) Functions
In the case of granular soil, the bentonite suspension penetrates into the sides under positive pressure and after a while forms a jelly. The bentonite suspension gets deposited on the sides of the hole not penetrate into the soil, but deposits only a this film on the surface of the hole. Under such condition, stability is derived from the hydrostatic head of the suspensions.

(C) Specification A-3.1 The bentonite suspension used for pilling work shall satisfy the following requirements:
(a) The liquid limit of bentonite when tested accordance with IS 2720 (Part V) 1965 shall be more 300% and less than 450%.
(b) The sand content of the bentonite powder shall not be greater than 7 per cent.
Note: The purpose of limiting the sand content is mainly to control and reduce the wear and tear of the pumping equipment.

(c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the bentonite solution should be about 1.12.

(d) The mash viscosity when tested by a Marsh cone should be about 37 second.

(e) The swelling index as measured by the swelled volume after 12 hours in abundant quantity of water shall be at least 2 times its dry volume.

(f) The pH value of the bentonite suspension shall be less than 11.5.

Permanent casing where specified shall be used to avoid aggressive action of water.

15.2.2 Boring for installing Pile
15.2.2.1 Installation of Piles: As described under clause 15.1.2
15.2.2.2 Deviation and Tolerance: As described under clause 15.1.2.2.

15.2.2.3 Procedure of Driving Pile Bore

(i) Bored cast-in-situ concrete piles are installed by making a bore into the ground and removing out the material.

(ii) The ground shall be roughly leveled and position of pile marked. The boring shall be done with or without the use of temporary casing. The sides of bore hole; shall be stabilized with the aid of temporary casing or with the aid of drilling mud of suitable consistency.

(iii) The equipment and accessories shall depend upon the type of bored pile chosen for the job, consideration of sub-soil strata, ground water condition, and type of founding material. Boring operation normally are done by rotary or percussion type drilling rigs using direct mud circulation on reverse mud tool shall be as detailed in IS 2911 (Part 1/Sec-2).

(iv) In case permanent/temporary casing is not used then bored pile is established with drilling fluid. Bentonite supplied to site shall conform to IS 2720 (Part V). A certificate shall be obtained by the contractor from the manufacturer showing properties of each consignment and should be submitted to the Engineer-in-charge. Bentonite shall be mixed thoroughly with fresh clean water to make a suspension which will Maintain the stability of the pile excavation for the period necessary to place concrete and complete construction. The temperature of the water used in mixing the Bentonite suspension and when supplied to bore hole shall not be lower than 5°C. Consistency of the drilling fluid suspension and when controlled throughout the boring as well as in concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with thick suspension of mud. Frequency and methods of testing drilling fluid shall be as specified and the test results shall be as specified in IS 2720 (Part V).

(v) Bored cast-in-situ piles in soils which are stable may often be installed with a small casing length at the top. A minimum of 2.0 m length of top of bore shall; invariably be provided with casing to ensure against loose soil falling in to drilling mud, or a suitable steel casing. The casing may be left in place permanently especially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour.

(vi) For bored cast-in-situ piles, casing/liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as directed by the Engineer-in-charge. Materials inside the casing shall be removed progressively by air lift, grapple or percussion equipment or other approved means.

(vii) Where bored cast-in-situ piles are used in soils liable to inflow, the bottom of the casing shall be kept low enough in advance of the boring tool; to prevent the entry of soil into the casing, thus presenting the formation of settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimize inflow of water or leakage of slurry during concreting.

(viii) Boring shall be carried out using rotary or percussion type equipment. Unless otherwise directed by the Engineer-in-charge the diameter of the bore holes shall be not more than the inside diameter of the liner.
(ix) After the boring has reached the required depth, the steel reinforcement shall be lowered in position maintaining the specified size of cover on all sides. The bore shall then be flushed with bentonite slurry and concreting shall be taken up exactly as described under Para 15.1.5.8

15.2.2.4 A proper record of pile driving and other details such as sequence of installation of piles, dimension of piles, depth bored, time taken for concreting etc. shall be maintained in sequence of occurrence at site as per clause. While drilling mud is used, the specific gravity of fresh supply and contaminated mud in the hole before concreting is taken up shall be recorded for first ten piles and subsequently at interval of 10 piles or as specified.

15.2.3 Reinforcement
As specified under para 15.1.4

15.2.4. Concrete
As specified under para 15.1.5

15.2.5 Ready Mix Concrete
As specified under clause 15.1.9.

15.2.6 Measurement
Dimensions shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured up to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating, driving etc.

15.2.7 Rate
The rate includes the cost of material and labour involved in all the operations described above including pile embedded in pile cap except reinforcement, pile cap and grade beam.

15.3 UNDER-REAMED RCC PILES
(i) Under reamed piles are bored cast-in-situ and bored compaction concrete types having one or more bulbs formed by suitably enlarging the bore hole for the pile stem. With the provision of bulb(s) substantial bearing or anchorage is available.

(ii) These piles find application in widely varying situations in different types of soils where foundation are required to be taken down to a certain depth in view of consideration’s like the following requirements:
(a) To avoid the undesirable effect of seasonal moisture changes as in expansive soils.
(b) To reach firm strata.
(c) To obtain adequate capacity for downward, upward and lateral loads and moments
(d) To take foundations below scour level.

(iii) When the ground consists of expansive soil e.g. black cotton soil, the bulb of the under ream pile provides anchorage against uplift due to swelling pressure apart from the increased bearing capacity.

(iv) In case of filled up or otherwise weak strata overlying the firm strata, enlarged base in the form of under reamed bulb in firm strata provides larger bearing area and piles of greater bearing capacity can be made.

(v) In loose to medium pervious sandy strata, bored compaction piles can be used as the process of compaction increases the loads bearing capacity of the piles.

(vi) Under reamed piles may also be used under situations where the vibration and noise caused during construction of piles are to be avoided. The provision of bulb(s) is of special advantage in under reamed piles to resist uplift and they can be used as anchors.

15.3.1 Pile Grouping
(i) For bored cast in situ under reamed piles at usual spacing of 2 Du, the group capacity will be equal to the safe load of individual pile multiplied by the number of piles in the group. For piles at spacing of 1.5 Du the safe load assigned per pile in a group should be reduced by 10%
(ii) In under-reamed compaction piles, at the usual spacing of 1.5 Du, the group capacity will be equal to the safe load on individual pile multiplied by the number of piles in the group. Note: In under-reamed compaction piles, the capacity of the group may be more than given in Para (i) above on account of compaction effect.

(iii) In non-expansive soils, when the cap of the pile group is cast directly on a reasonably firm stratum it may additionally contribute towards the bearing capacity of the group.

(iv) In load bearing walls piles should generally be provided under all wall junctions to avoid point loads on beams. Position of intermediate piles is then decided by keeping door openings fall in between two piles as far as possible.

15.3.2 Equipment and Other Accessories

(i) The selection of equipment and accessories will depend upon the type of under-reamed piles, site conditions and nature of strata. Also it will depend on economic considerations and availability of manually or power operated equipment.

(ii) A typical list of equipment for manual construction is as below.

1 Equipment

1.1 Normally the following equipment will be required in manual operation:
(a) An auger;
(b) An under-reamer;
(c) A boring guide; and
(d) Accessories like spare extensions, cutting tool, concreting funnel etc.

1.1.1 For the piles of size larger than 30 cm and for larger depths additional equipment required will be portable tripod hoist with a manually operated winch.

1.1.2 For piles in high ground water table and unstable soil conditions, boring and under-reaming shall be carried out with bentonite slurry using suitable equipment. Tremie pipe shall be used for concreting
(a) Drop weight for driving the core assembly, and
(b) Pipe or solid core.

(iii) Bore holes may be made by earth augers. In case of manual boring, an auger boring guide shall be used to keep bores vertical or to desired inclination and in position. After the bore is made to the required depth, enlarging of the base shall be carried out by means of an under-reaming tool.

(iv) In ground with higher water table having unstable pile bores, boring and under-reaming may be carried out using suitable drilling mud. General guidelines for bentonite drilling mud are given in para 15.2.12. In normally met soil strata, drilling mud can be poured from top while boring and under-reaming can be done by normal spiral earth auger and under-reamer.

(v) The level of drilling mud should always be about one meter above water table or the level at which caving-in occurs. In case of very unstable strata with excessive caving-in continuous circulation of drilling mud using suitable pumping equipment and tripod, etc along with modified auger and under-reamer may be used.

(vi) Sometimes permeable strata overlying a rim clayey stratum may be cased and normal boring and under-reaming operation may be carried out in clayey stratum.

(vii) To avoid irregular shape and widening of bore hole in very loose strata at top a casing pipe of suitable length may be used temporarily during boring and concreting.

(viii) For improved control over the inclination of batter/ranker piles a tripod hoist with fixed pulley should be used for lowering in of under-reaming tools.

(ix) For placing concrete in bore holes full of drilling mud or sub-soil water tremie pipe of not less than 150 mm diameter with flap valve at the bottom should be used.

(x) For batter/raked under-reamed piles the reinforcement cage should be placed guiding it by a chute or any other suitable, method. If concreting is not done by tremie, it should be done by chute.
(xi) In under-reamed compaction piles, suitable device should be used for guiding the movement of drop weight and specified core assembly for its vertical driving for operating the drop weight and specified core assembly for its vertical driving for operating the drop weights of adequate capacity, suitable winch with hoisting attachment should be used.

15.3.3 Pile Boring
(i) Under-reamed piles may be constructed by selecting suitable installation techniques at given site depending on sub-soil strata conditions and type of under-reamed piles and number of bulbs.

(ii) In construction with equipment suggested under para 15.3.2.(ii) initially boring guide is fixed with its lower frame leveled for making desired angular adjustment for piles at batter/rake. Boring is done up to required depth and under-reaming is completed.

(iii) In order to achieve proper under-reamed bulb, the depth of bore hole should be checked before starting under reaming. It should also be checked during under-reaming and any extra soil at the bottom of bore hole; removed by auger before reinserting the under-reaming tool.

(iv) The completion of desired under-reamed bulb is ascertained by
   (a) The vertical movement of the handle and
   (b) When no further soil is cut.

(v) In double or multi under-reamed piles, boring is first completed to the depth to the first (top) under-ream only and after completing the under-reaming boring is extended further for the second under-ream and the process is repeated.

15.3.4 Control of Alignment
(i) The piles shall be installed as correctly as possible at the correct location and truly vertical (or at the specified batter/inclination). Great care shall be exercised in respect of single pile or piles in two pile groups under a column.

(ii) As a guide for vertical piles a deviation of 1.5% and for ranker piles a deviation of four percent shall not normally be exceeded. In special cases, a closer tolerance may be necessary.

(iii) Piles shall not deviate more than 75 mm or one quarter the stem diameter, whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from the designed position at the working level.

(iv) In case of single pile under a column the positional deviation should not be more than 50 mm or one quarter of the stem diameter whichever is less (100 mm in case of piles having diameter more than 600 mm).

(v) For piles where cut-off is at substantial depths, the design should provide for worst combination of the above tolerances in position and inclination.

(vi) In case of piles deviating beyond these limits corrective measures where necessary may be taken in the form of increasing pile size, provision of extras reinforcement in the pile, redesign of pile cap and pile ties. If the resulting eccentricity cannot be taken care of by the above measures, the piles should be replaced or supplemented by; one more additional piles.

15.3.5 Reinforcement in Piles
(i) The provision of reinforcement will depend on nature and magnitude of loads, nature of strata and method of installation. It should be adequate for vertical loads, lateral load and moments acting individually or in combination- It may be curtailed at appropriate depths only under the advice of the structural engineer. However, provision of reinforcement shall be as specified in drawing.

(ii) The minimum area of longitudinal reinforcement (any type or grade) within the pile shaft should be 0.4 % of the sectional area calculated on the basis of outside area of shaft or casing if used.

(iii) Reinforcement is to be provided in the full length irrespective of any other considerations and is further subject to condition that a minimum number of three 10 mm dia mild steel or three 8 mm dia
high strength steel bars shall be provided. The transverse reinforcement as circular stirrups shall not be less than 6 mm dia. Mild steel bars at a spacing of not more than the stem diameter or 30 cm, whichever is less.

(iv) For under reamed compaction piles, a minimum number of four 12 mm diameter mild steel or four 10 mm diameter high strength steel bars shall be provided.

(v) For piles of lengths exceeding 5 m and or 37.5 cm diameter, a minimum number of six 12 mm diameter HSD bars shall be provided.

(vi) For piles exceeding 40 cm diameter a minimum number of six 12 mm diameter high strength steel bars shall be provided.

(vii) The circular stirrups for piles of length exceeding 5 m and diameter exceeding 37.5 cm shall be bars of 8 mm diameter.

(viii) For piles subject to uplift loads, adequate reinforcement shall be provided to take full up lift which shall not be curtailed at any stage.

(ix) For piles up to 30 cm diameter, if concreting is done by tremie, equivalent amount of steel placed centrally, may be provided at sides.

(x) The minimum clear cover over longitudinal reinforcement shall be 50 mm. In aggressive environment of sulphate etc. it may be increased to 75 mm.

15.3.6 Concrete

15.3.6.1 Materials: Cement, water, fine aggregate, coarse aggregate and chemical admixtures etc. as described under clause 15.1.5.

15.3.6.2 Concrete grades to be adopted: Same as described under clause 15.1.6.5.

15.3.6.3 Workability of Concrete: Same as described under clause 15.1.6.6.

15.3.6.4 Placing of Concrete

(i) Same as Para (i) to (x) under clause 15.1.6.7,

(ii) Concreting shall be done as soon as possible after completing the pile bore. The bore hole full of drilling mud should not be left un-concreted for more than 12 to 24 hours depending upon the stability of the bore hole.

(iii) For placing concrete in pile bores, a funnel should be used and method of concreting should be such the entire volume of the pile before is filled up without formation of voids and/or mixing of soil and drilling fluid in concrete.

(iv) In empty bore holes for under-reamed piles a small quantity of concrete is poured to give about 100 mm layer of concrete at bottom. Reinforcement is lowered next and positioned correctly. Then concrete is poured to fill the bore hole. Care should be taken that soil is not scrapped from side if rodding is done for compaction. Vibrators shall not be used.

(v) If water is confined up to the bucket length portion at the toe & seepage is low, the water should be bailed out and concreting should be done as prescribed in Para (iv) above.

(vi) In case the pile bore is stabilized with-drilling mud or by maintaining water head within the bore hole, the bottom of bore hole shall be carefully cleaned by flushing it with fresh drilling mud and pile bore will be checked for its depth immediately before concreting-

(vii) Concreting shall be done by tremie method. The tremie should have a valve at bottom and lowered with valve closed at the start and filled up with concrete. The valve is then opened so permit the flow of concrete which permits upward displacement of drilling mud,

(viii) The pouring should be continuous and tremie is gradually lifted up such that the tremie pipe
opening remains always in the concrete. At the final stage the quantity of concrete in tremie should be
enough so that on final withdrawal some concrete spills over the ground.

Note:
(1) The concrete should be coherent, rich in cement (not less than 350 kg/m$^3$) and slump not less than 150 mm.

(2) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

(ix) In inclined piles, concreting should be done through a chute or by tremie method.

(x) For under-reamed bored compaction piles, the pile bore is first filled up without placing any reinforcement. Concreting is done as prescribed in para (iv) depending upon the situation. Soon after the specified core assembly shall be driven and extra concrete shall be poured in simultaneously to keep the concrete up to ground level. If hollow driving pipe is used in core assembly the pipe shall be withdrawn after filling it with fresh concrete which will be left behind.

15.3.6.5 **Estimation of Concrete Quantity**

(i) The extra quantity required for each bored cast-in-situ under-reamed bulb of 2.5 times the stem diameter may be taken equal to a stem length of 4 to 4.5 times its diameter, depending upon the nature of strata and other site conditions. The volume of concrete actually placed shall be observed in the case of quantities of the concrete and cement for the subsequent piles.

(ii) For under-reamed compaction piles the amount of concrete used is about 1.2 times of the under-reamed cast-in-situ piles.

Note: If the estimates of concrete consumption are on the volume of the bore holes and not on the basis of concrete quantity actually consumed, the concrete used may be found lesser than estimated and cement consumption may work out to be less.

15.3.6.6 **Placing Concrete under Water:** As described under clause 15.1.6.9.

15.3.6.7 **Testing Works Concrete:** As described under clause 15.1.6.

15.3.6.8 **Curing:** As described under clause 15.1.7.

15.3.6.9 **Ready Mix Concrete (RMC):** As described under clause 15.1.9.

15.3.7 **Pile Cap (Fig. 15.2 and 15.3)**

(i) Pipe cap are generally designed considering pile reaction as either concentrated loads or distributed loads. The depth of pile cap should be adequate for the shear, diagonal tension and it should also provide the necessary anchorage of reinforcement both for the column and the pile.

(ii) The pile caps may be designed by assuming that the load from column or pedestal is dispersed at 45° from the top of the cap up to the mid depth of the pile cap from the base of the column or pedestal. The reaction from piles may also be taken to be distributed at 45° from the edge of the pile, up to the mid depth of the pile cap on this basis, the maximum bending moment and shear forces should be worked out at critical sections.

(iii) Full dimension of the cap shall be taken as width to analyses the section for bending and shear in respective direction. Method of analysis and allowable stresses may be according to IS 456.

(iv) The clear overhang of the pile cap beyond the outermost pile in the group shall normally be 100 to 150 mm depending upon the size of the pile.

(v) The cap is generally cast over a 75mm thick leveling course of concrete. The clear cover for the main reinforcement of cap slab shall be not less than 75mm.

(vi) The pile should project 50mm into the cap concrete.
15.3.8 Grade Beams

(i) The grade beams supporting the walls; shall be designed taking due account of arching effect due masonry above beam. The beam with masonry due to composite action behaves as a deep beam.

(ii) The minimum overall depth of grade beams shall be 150 mm. The reinforcement at bottom should be kept continuous in all the beams and an equal amount may be provided at top to a distance of quart span both ways from the pile centre.

(iii) The longitudinal reinforcement both at bottom and top should not be less than three bars of 10 mm diameter mild steel (or equivalent deformed steel).

(iv) Stirrups of 6 mm diameter bars should be at 300 mm spacing which should be reduced to 100 mm at the door openings near the wall edge to a distance of three times the depth of beam. No shear connectors are necessary in wall.

(v) In expansive soil the grade beam shall be kept a minimum of 80 mm clear off the ground. In other soils, the beams may rest on ground over a leveling concrete course of about 80 mm as shown. In this case part load may be considered to be borne by ground and it may be accounted for; in the design of piles. However, the beams should be designed as usual.

(vi) In case of exterior beams over piles in expansive soils a ledge projection of 75 mm thickness an extending 80 mm into ground as shown shall be provided on outer side beam. Typical sections of internal and external beams are shown below:-

15.4 DRIVEN PRECAST R.C.C. PILES

Driven Precast Concrete Pile is a pile constructed in a casting yard and subsequently driven in the ground with or without jetting, or other technique like preboring (depending on the conditions of soil) when the pile has attained sufficient strength. By driving, the subsoil is displaced and remains in direct contact with the pile. These piles find wide application particularly for structures such as wharves, etc. to act as a free standing pile above the soil/water level or where conditions are unfavorable for use of cast-in-situ piles.

15.4.1 Reinforcement

(i) The longitudinal reinforcement of specified grade and size shall be provided in the pre-cast concrete piles, for the entire length. All the longitudinal bars shall be of same length and should fit tightly in the pile shoe if the same is provided.

(ii) Extra bar for supporting the longitudinal steel shall be provided, to resist the local bending moments but the same should be detailed in the drawings prominetly so that sudden discontinuity can be avoided. The non provision of the extra bars may lead to cracks in the pile during heavy driving,
(iii) As per IS 2911 (Part/Sec.3) the area of main longitudinal reinforcement shall not be less than the percentages of cross sectional area of the piles as detailed below:
(a) Piles with a length 30 times the least dimension: 1.25%
(b) Piles with a length 20 to 40 times the least dimension: 1.5%
(c) Piles with a length more than 40 times the least dimension: 2%

(iv) The lateral reinforcements, which are normally in the form of hooks and links of not less than 6 mm diameter TMT bars, has its own particular importance in resisting the driving stresses induced in the pile. The volume of lateral reinforcement shall not be less than the following:
(a) At both ends of the pile for a distance of 3 times the least Width - not less than 0.6 % of the gross volume of pile.
(b) At central portions of the pile - not less than 0.2% of the gross volume of pile.

(v) The spacing of the lateral ties in a pile shall be so arranged that the concrete should have free flow around the reinforcements. The gradual transition of close spacing of lateral reinforcements near the ends to the increased spacing in the central portions of the piles should be accommodated by gradually increasing the spacing of the ties in a length of 3 times the least width of the pile.

(vi) The cover to reinforcement should be provided to longitudinal bars. In normal conditions the cover thickness to be provided is 50 mm and in case the piles are exposed to sea water or water having other corrosive contents the minimum thickness of cover shall be 75 mm.

Note: Where the concrete of pile is liable to attack of sulphate, chlorides present in ground water a minimum cover thickness of 75 mm shall be provided. In addition, the piles may be coated with some suitable material.

(vii) Each longitudinal bar shall be in one length as far as possible, also preferably the full length bar shall be used. However, in unavoidable cases if the bars are to be joined, they shall be done by butt welding duly staggering the joints.

(viii) The hoops or links that are to be tied to longitudinal reinforcement shall be tied with the specified type of binding wire and the free ends of the wire shall be turned into the interior of the pile.

(ix) Preferably the hoop or link reinforcement shall be welded to the longitudinal bars so as to achieve a tight fitting.

(x) Temporary or permanent spreader forks spaced at 1.5 m shall be used to keep the longitudinal bar in proper position and spacing.

(xi) Before concreting, the reinforcements shall be checked by Engineer-in-charge who shall ensure that the reinforcements are tied as per approved design and drawing and shall ascertain that the tying is perfect.

15.4.2 Equipment and Ancillaries
(i) The selection of equipment mostly depends upon the hardness of the strata. For deriving the size and weight of the pile to be handled, the most important point is the location of work.

(ii) Generally, the following equipments are necessary for the installation of piles
(a) Movable steel or timber structure duly designed to handle the pitching and driving the piles to the correct position and alignment.
(b) Tackles to handle piles from casting/stacking yard.
(c) To prevent the head of the pile from being damaged during drilling operation and to distribute the blow over the cross section of the head of the pile. A temporary steel driving cap, normally termed as 'Drive cap' is placed on the top of the pile.
(d) A pad, block or packing of hard wood some suitable resilient material normally termed as "Dolly" is fixed to the upper portion of the cap (helmet) for preventing the shock from hammer on the head of the pile.
(e) A single acting" or "double acting" hammer is used depending on whether the hammer is allowed to
fall under gravity along or is operated with the source of motive power to derive the energy.

(f) Sometimes it so happens that he piles are to be driven below the pile frame leaders, with the result
the hammer may not be in a position to reach the pile. Under such circumstances a removable
extension piece known as "follower" or "long dolly" is used to transmit the hammer blows over the pile
head.

(g) When a particular type of soil strata is met with, the driving conditions may require equipments for
jetting/p re-boring for installation of piles.

(h) When the piles are to be driven in rock, coarse gravel, clay with cobbles, or other soils, which may
damage the tip of the pile, flat or coaxial shoes made out of steel or cast iron shall be provided at the tip
of the pile.

(i) While driving a pile in a uniform clayey soil or sandy soil no advantage can be derived by tapering
the tip of the pile hence no shoe need be provided for the tip of the pile while driving piles in such soils.

(j) When jetting is to be undertaken a jet tube may be cast into the pile by connecting the same to the
pile shoe which is normally provided with jet holes. It is not advisable to provide a central which is likely
to be choked.

(k) The best results can be achieved by providing four holes in four directions. However, providing two
holes in opposite direction may also serve the purpose.

(l) Alternatively, two or more Jet pies may be attached to the sides of the pile. The pile may get off
loaded if proper balanced arrangement of jet is not made.

15.4.3 Concrete
15.4.3.1 Materials: Cement, water, fine and coarse aggregate, chemical admixtures etc. As described
under clauses 15.1.5.

15.4.3.2 Concrete Grades to be Adopted: Same as described under clause 15.1.6.5

15.4.3.3 Workability of Concrete: The degree of workability in this case is "low" as the concrete is
placed where the section is not heavily reinforced, also the concrete in the pile is vibrated with internal
as well as external vibrators, and therefore minimum slump should be 25 mm to 50 mm.

15.4.3.4 Form-Work/Mould
(i) Only steel moulds manufactured out of sturdy steel sections and sheets to cast the required size of
the pile are to be used. Timber moulds shall not be permitted, under any circumstances.

(ii) The mould shall sustain the stresses generated due to the use of immersion/plate vibrators and
some time even form vibrator, depending upon the size and strength of the pile to be cast.

(iii) The manufacturing of the mould shall be so simple that the sides could be opened within 16 to 24
hours of casting by simply loosening the bolts without damaging the edges of the pile.

(iv) Fixing supports for the sides of the mould shall be done from outside and no use of through bolts
through the concrete shall be permitted to support the opposite sides of the mould.

(v) Proper mechanism shall be introduced to fix the sides to the top of the casting platform so that the
plate from vibrators can be operated without disturbing the mould.

(vi) In case of square piles provision for forming champ hers of the pile for the corners shall be made in
the mould itself.

(vii) The mould should be such that when the pile is demoulded all the surfaces of the pile except the
side from which the concrete is laid should get form finish. No rendering or finishing shall be permitted
on any surface of the concrete after demoulding.
(viii) Piles whose surfaces are plastered or rendered, edges repaired etc, shall be rejected and removed from site.

(ix) After every casting, when the sides of the mould are opened the same shall be cleaned nicely and form oil manufactured by reputed company shall be applied over the surface before the mould is adjusted for filling the concrete, for next pile. The normal practice of applying grease mixed with diesel or waste oil instead of the form-oil shall not be permitted.

15.4.4 Casting Concrete Piles (Pre-casting)
(i) The casting yard shall be so constructed that the piles that are cast can be lifted directly from their beds and transported to the storing yard with minimum handling and avoiding any damage to the pile.

(ii) The casting yard shall have well drained surface so that the water used for curing the already cast piles do not accumulate on the yard inconveniencing the working on subsequent piles.

(iii) The size of the casting platform shall be large enough to accommodate the minimum number of piles to be cast for full 11 days depending upon the proposed progress of work per day, as a pile once cast cannot be lifted from the casting bed till the expiry of ten days, therefore no piles can be cast on these spaces till the piles more than 10 days old are shifted.

(iv) The casting yard shall be well covered not only from top but also from sides to avoid the direct sun-rays falling on the piles that are under set. The pile should also be protected from rain and wind.

(v) Before taking up actual concreting, the moulds to be concreted for full days work shall be fixed in position and preferably moulds for concreting on the subsequent day shall also be kept ready in advance.

(vi) If the contractor is permitted to start concrete with lesser number of moulds than that can be cast within a day, the action will prompt the contractor to open the sides of moulds already cast prematurely to continue concreting for the full day, which is not desirable as the quality of the concrete will be hampered.

(vii) The inner faces of the mould shall be cleaned; form-oil of approved brand and manufacture shall be applied.

(viii) The reinforcements shall be lowered carefully in the mould and fixed in position with proper - cover blocks and spacers on all surfaces.

(ix) On getting formal approval of the Engineer-in-charge for the fixing of form-work in position and on getting the pre-measurements of the reinforcements recorded, concreting with specified grade shall be taken up. The slump should be checked frequently and constant w/c ratio shall be maintained.

(x) The piles should be cast from end to end, using immersion, form vibrators, avoiding over vibration. Proper care should be taken to see that the concrete is packed in the mould and consolidated. When the mould is tuff the top surface of concrete shall be neatly toweled and finished smooth.

(xi) Proper precaution shall be taken to ensure that the vibration from the adjoining work does not affect the previously placed concrete for piles during setting period.

(xii) On completing the concreting for a particular pile the following information shall be engraved (not painted) on each pile.
(1) Date of casting.
(2) Grade of concrete used.
(3) No. of lot.

The lot No. will help to locate the exact position where the particular pile has to be used.

15.4.5 Testing Works Complete
As prescribed under para 15.1.6
15.4.6 Ready Mix Concrete
As prescribed under para 15.1.9.

15.4.7 Curing
(i) Provision for curing as given under clause 15.1.7 shall be followed in addition.

(ii) The piles shall not be lifted from the casting bed for a minimum period of 10 days from the date of casting.

(iii) When the piles are shifted to stacking yard after the expiry of ten days, where the piles will have to be kept for a period of 28 days from the date of casting, the piles in stacks shall be covered with sacks so that the piles do not come in contact with sun rays till they attain full strength.

(iv) Lastly, the most important factors affecting the time of curing are the method of curing, weather during hardening, probable hardness of driving and the method of lifting and pitching.

(v) The Engineer-in-charge may fix up the exact period of curing for a particular project considering all the factors mentioned in Para (iv) above.

15.4.8 Storing and Handling
(i) After the expiry of 10 days from the date of casting, the piles are to be removed from the casting bed and shifted to the stacking yard where the piles shall be kept for a further period of 18 days i.e. 28 days after casting and later till they are carried for driving.

(ii) The piles shall be stored on a firm ground which will not liable for unequal subsidence or settlement under the weight of the stack of piles.

(iii) Timber sections of suitable size shall be placed over the level ground to stack the piles on tap. The spacing between the timber sections shall be so adjusted that the piles are not subjected to undue bending stresses, while in stack.

(iv) Spaces shall be left around the piles in the stack so that they can be lifted without difficulty and necessary piles can be cured beyond 10 days.

(v) The order of stacking the piles shall be such that the older piles can be withdrawn without disturbing the newly placed piles. Separate stacks shall be provided for the piles of different lengths.

(vi) If ordered by the Engineer-in-Charge or if weather conditions so require arrangements for curing the piles for further period shall be made when the piles are stored in the stack.

(vii) Care shall be taken to see that the piles are not damaged or cracked at the time of lifting, handling, transportation, etc.

(viii) While transporting the piles from the stocking yard to the site, the piles shall be supported at approximate lifting holes provided for the purpose. In case during transportation if the piles are to be unloaded temporarily they shall be placed on trestles or blocks located at the lifting points.

15.4.9 Driving Piles
(i) Though from the consideration of maintaining the time schedule and economy in construction, the pre-cast concrete piles have to be driven without any possible delay, still it shall be kept in mind that the piles chosen for driving should be thoroughly cured and are sufficiently hard. To achieve this proper schedule shall be followed, in the operations of casting, curing, stacking and transportation of piles to site.

(ii) The heads of the pre-cast concrete piles to be driven shall be protected with packing of resilient material against the possible damage due to the use of heavy hammers. Care shall be taken to see that packing is evenly spread and placed securely. On top of the packing a helmet should be placed and provided with dolly a hard wood or any suitable material not thicker than the width of the pile.

(iii) The failure in the pile may occur by compression or tension when the blow of the hammer generates the stress waves which traverses the length of the pile. Failure due to compressive stresses mostly
occurs at the heads. Head stresses are independent of ground conditions and mainly depend upon the weight of the hammer, its drop and the stiffness of the head cushion.

(iv) By using heaviest hammer and softest packing the maximum set for a given stress is obtained. The drop of the hammer however should be adjusted to suit the allowable stress in the concrete.

(v) Optimum driving conditions can be maintained only by regular replacement of packing materials as prescribed in Para (ii) above, since the stiffness in head packing materials increases with repeated use.

(vi) Only in cases of exceptionally hard driving, where theoretically the compressive stresses of toe can reach twice the head stresses, failure in lower portions of the pile can occur. In practice however, this rarely occurs as the compressive stresses to a great extent tend to be uniform over the considerable length of the pile.

(vii) Due to reflection of compressive wave to "free end", the longitudinal tension is caused in the pile. This situation arises at a time when the ground resistance is low and/or when the hammer rebounds due to head conditions mainly because of the use of hard packing and light hammer. In addition, an unsupported long pile negotiating a hard stratum will be subjected to transverse or flexural vibrations in the pile in case the blow from the hammer becomes non-axial or if the pile is not restrained to reduce the effect of a long pile.

(viii) For driving a pile; any type of hammer can be used provided the pile penetrates to the prescribed depth or attain the specific resistance without getting damaged.

(ix) The hammer, helmets, dolly and the pile below should be co-axial and should sit perfectly one over the other. However, the heaviest possible hammer should preferably be used and the stroke should be so managed so as not to damage the pile.

(x) The choice of hammer mainly depends upon whether the pile is to be driven to a given resistance or to a given depth.

(xi) Normally, for a single acting or a drop hammer the stroke should be limited to 1.2 m but 1.0 m is preferable. Shorter stroke may be used in cases where there is a danger of damaging the pile, a few examples of which are described below:

(a) Hard surface has to be penetrated in the early stages when a long pile has to be driven.
(b) When there is a soft ground up to a considerable depth, a large penetration is achieved at each blow,
(c) The pile suddenly reaches refusal when it meets with rock or other virtually impenetrable soil.

(xii) If a satisfactory set is achieved for ten consecutive blows with an appropriate hammer and drop the method of driving should be repeated with caution and long continued driving. However, after the pile has almost ceased to penetrate the driving should be stopped especially when the hammer with moderate weight is used.

(xiii) Sometimes it so happens that the rate of penetration suddenly changes without any satisfactory reasoning or soil conditions. Under such circumstances the pile driving should not be continued till real problem is investigated and remedy thought over.

15.4.9.1 Jetting with Driving Pile

(i) The jetting operation is effective only in the cohesion less soils such as sand, gravel and fine grained soils with very less percentage of clay. The jetting will be ineffective in clay soils.

(ii) The main purpose of jetting is to minimize or almost eliminate the resistance at the toe and at the same time the frictional resistance along the surface of the pile shaft also gets reduced.

(iii) Very hard driving and vibrations can be avoided when the toe resistance is eliminated and also the rate of penetration is increased considerably when compared to the normal driving methods without jetting.

(iv) Jetting operations shall be carried out only when specifically ordered by the Engineer-in-Charge. Jetting shall be carried in a manner that the stability of soil and the bearing capacity of piles already
driven is not in any way impaired. Similarly, the safety of the adjoining structures shall be taken into consideration.

(v) For effective jetting the quantity of water required is directly related to the cross sectional area of the piles (including external jet pipes). In dense cohesion less soils the quantity of water up to 2 liters per minute per sqcm. of pile cross section may be required. Less quantity of water may be needed in loosely compacted soils.

(vi) The water pressure to be maintained is between 5.6 kgf/cm$^2$ to 10.6 kgf/cm$^2$ or more- enlarge quantities of water are used the draining arrangement for the water that emerges on the ground shall have to be made otherwise the stagnant water may soften the ground endangering the piling equipment resting above.

(vii) To minimize the risk of blockages, the nozzle should not be positioned at the point of the toe. The arrangement of Jets should be balanced to ascertain the penetration of the pile vertically. It is advisable to surge down an independent pile or two pipes may be attached to the opposite sides of the pile for effective jetting operation.

(viii) The pile shall be allowed to enter the ground gradually after operating the water under the weight of pile and the hammer. Acceptable verticality may be achieved by use of rigid leaders, duly controlling the rate of penetration with a pile winch.

(ix) On achieving maximum apparent penetration with light driving by the method prescribed above and when the water jets are running the further penetration may be attained in the cohesion less soils. The piles shall be driven to the final position or set when the Jetting is complete.

(x) Before closing the driving operation, the jetting should be stopped and the driving shall be continued by ordinary driving methods. If due to the ground disturbances, the pile tips tend to be drawn towards the piles already driven, Jetting should be stopped immediately.

(xi) The correct working of jets should be tested before the work on driving the pile is commenced. If the pile is not provided with a "built in jet arrangement" independent jet pipes down the outside the pile can be used and to achieve the best result jets working on several faces of the pile can be practical which will also assist maintaining the verticality.

15.4.9.2 Stripping Pile Heads
(i) Stripping of pile shall be done in such a manner that a minimum 50 mm length of pile projects into the pile cap. Sufficient length of reinforcement from the pile shall be exposed for embedding the same inside the pile cap.

(ii) The stripping operation or exposing the reinforcement of the pile shall be done very carefully without damaging the pile proper. In case any portion of the concrete cracks, the defective portion shall be cut and the portion repaired with new concrete joining properly with old concrete.

15.4.9.3 Lengthening Piles
(i) Sometimes the length of a pile has to be increased either before or during driving; this can be done by casing additional concrete over the old pile. In such cases the original head of the pile is cut to expose minimum 200 mm length of bar.

(ii) The exposed steel should be cleaned properly and shall be held in firm position, while full penetration butt welding is done.

(iii) In case the conditions on site are not favorable to attempt butt welding, a minimum length of 40 d (40 times the diameter of main bar) of the original pile shall be exposed and the new steel should be overlapped over the exposed steel. The overlap shall be spot welded.

(iv) On completion of welding/overlapping the reinforcement and tying the spirals, for the extended length of reinforcements the extras portion of the pile can be concreted thus extending the original pile.

15.4.10 Risen Piles
(i) Sometimes due to ground heave there is a possibility that piles already driven to the final depth may
start rising when adjacent piles are being driven; such rising shall be noted at frequent intervals till driving on adjacent piles is in progress.

(ii) On completion of driving the adjacent piles, the piles that are risen shall again be driven back either to their original level or up to a point of resistance.

15.4.11 Pile Cap
As per in para 15.3.7,

15.4.12 Grade Beam
As per in para 15.3.8.

15.4.14 Measurement
Dimension shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured from top of shoe to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating and driving etc.

15.4.15 Rate
The rate includes the cost of materials and labour involved in all the operations described above including pile embedded in pile cap, centering, shuttering except reinforcement, pile cap and grade beam.

15.5 LOAD TEST ON PILES
The bearing capacity of a single or group of piles shall be determined from test loading. It is most direct method for determining safe load on pile and it is more reliable on account of its being in-situ test. The load test on a concrete pile shall not be carried out earlier than 28 days of its casting. Initial test shall be carried on test pile which is not used as working pile and Routine tests shall be carried out as a check on working pile. Routine test shall be one-half percent to two percent of total number of piles or as specified, applicable to vertical and lateral load. Load Test shall generally conform to provision made in IS 2911 (Part IV) which provides guidelines for determination of safe loads and conducting of different types of tests.

15.5.1 Types of loadings/tests
(i) Vertical Load Test (Compression)
(ii) Cyclic Vertical Load Test
(iii) Lateral Load Test

15.5.2 Vertical Load Test
15.5.2.1 General: Compression load shall be applied to the pile top by means of a hydraulic jack against suitable load frame which is capable of providing reaction and settlement is recorded by suitable dial gauges. The contractor shall apprise of Engineer-in-Charge before test is conducted.

15.5.2.2 Preparation of Pile Head: Pile head shall be chipped off to horizontal plane, projecting steel shall be cut or bent and top finished smooth and leveled with plaster of Paris or similar synthetic material as specified to give a plane surface which is normal to the axis of the pile. A bearing plate with a hole at the centers shall be placed on the head of pile for the Jacks to rest.

15.5.2.3 Loading Platform: A proper loading platform is installed as specified. Contractor shall ensure that when the hydraulic jack and load measuring devices are mounted on pile head the whole system will be stable on the maximum specified load. For single pile two dial gauges shall be fixed to the p-e and bear on surfaces on reference frame. The dial gauges shall be placed in diametrically opposite positions and be equidistant from the pile axis. Four dial gauges are used for groups, having 0.01 mm sensitivity. The arrangement shall be approved by the Engineer-in-charge.

15.5.2.4 Application of Load: The test is carried out by applying a series of downward incremental load (20 per cent of safe loads on pile). In this method application of increment of test load and taking of measurement or displacement in each stage is maintained till the rate of displacement is either 0.1 mm in first 30 minutes or 0.2 mm in first one hour or 2 hours, whichever occurs first. The test load shall be maintained for 24 hours. This method is applicable for both initial and routine test. For testing of raker piles the loading shall be along its axis. Safe load on single pile for initial test is least of following:
(i) Two-thirds of the final load at which the total displacement attains a value of 12 mm unless otherwise stated, in such case the safe load should be corresponding to total displacement permissible.

(ii) 50% of the final load at which the total displacement equal 10% of pile diameter and 7.5% of bulb diameter in case of underreamed piles. Routine test shall be carried for a test load of one and half times the working load, maximum settlement not to exceed 12 mm or as stated. Safe load on group of piles for initial test shall be least of the two (i) Final loads at which total displacement is 25 mm or as stated. (ii) Two-thirds of final load at which the total displacement is 40 mm. Routine test shall be carried for a test load equal to not less than working load, the maximum settlement not to exceed 25 mm.

15.5.2.5 Maintained Load Method: This is applicable for both initial and routine test. In this method application of increment of test load and taking of measurement or displacement in each stage of loading is maintained till rate of displacement of the pile top is either 0.1 mm in first 30 minutes or 0.2 mm in first one hour or till 2 hours, whichever occurs first. If the limit of permissible displacement as given in 15.3.4 is not exceeded, testing of pile is not required to be continued further. The test load shall be maintained for 24 hours.

Pile test data such as load, displacement and time shall be recorded in suitable prescribed tabular form. Results can be presented by suitable curves.

Test shall be carried out in proper manner and to the entire satisfaction of the Engineer-in-charge. After the test is completed the test cap shall be dismantled and pile surface shall be resorted to original shape.

15.5.2.6 Measurement: Each completed test shall be enumerated for initial test, routine test separately.

15.5.2.7 Rate: The rate includes the cost of labour, material and all the operations described above such as preparatory work including installation of loading platform, applying toad, preparing pile head for load test, trimming of pile head etc. complete.

15.5.3 Cyclic Vertical Load Testing
15.5.3.1 General: This process shall be used in case of initial test to find out separately skin friction and point bearing load on single piles of uniform diameter in conformity of provisions of IS Code 2911 (Part 4) for conducting of the test.

15.5.3.2 Preparatory Pile Head: As per clause 15.5.2.2.

15.5.3.3 Loading Platform: As per clause 15.5.2.3

15.5.3.4 Application of Load: Relevant provision as per para 15.5.2.4 shall be applicable. The test may be continued up to 50 per cent over the safe load.

15.5.3.5 Test procedure shall be followed as per below procedure.
1 Method
1.1 Alternate loading and unloading shall be carried out at each stage as in 15.5.2.4 and each loading stage shall be maintained as in 15.5.2.5 and each unloading stage shall be maintained for at least 15 minutes and the subsequent elastic rebound in the pile should be measured accurately by dial gauges as in 15.5.4.(iii). The test may be continued up to 50 % over the safe load.

2 Analyses of Results for Frictional Resistance
2.1 Graphical Method
2.1.1 Assuming that there is no compression in type pile, plot a graph relating total elastic recovery and load at the pile top.

2.1.2 Draw a straight line parallel to the straight portion of curve I to divide the load into two parts and thereby obtained approximate values of point resistance and skin friction.

2.1.3 From the approximate value of skin friction, and knowing the loads of top of pile, compute the elastic compression of the pile corresponding to these loads, by the following formula:
A = \frac{(T-F/2)L}{AE}

Where
\Delta = \text{Elastic compression of pile in cm},
T = \text{Load on pile top in kg},
F = \text{Frictional resistance in kg},
L = \text{Length of the pile in cm},
A = \text{Cross-sectional area of the pile in cm}^2
E = \text{Modulus of elasticity of the pile material in kg/cm}^3
(The value should normally be measured from an exposed portion of pile stem by means of compress
meter during the load test itself.)

2.1.4 Obtain values of the elastic compression of the sub grade by subtracting the elastic compression
of the pile from the total elastic recovery of pile, and plot the graph relating these new values the
negative value shall be ignored until the value is positive.

2.1.5 Repeat the procedures given in para 2.1.3 above to obtain new values of skin friction.

2.1.6 The process of further approximations covered in para 2.1.6 above may be repeated further to
any desired extent, but usually the third curve would give sufficiently accurate values for skin friction for
practical purposes.

2.2 Analytical Method
Analysis of Cyclic Load Test Data for Separation of Skin Friction and Point Resistance.

2.2.1 From straight line portion of curve calculate the value of constant from the equation.
\[ m = \frac{\Delta s - (AT/AE)L}{\Delta T} \]
Where  \( m \)  = A
constant;
\( \Delta s \) = Change in total elastic settlement of pile
\( \Delta T \) = Change in applied load = \( (T_b - T_a) \) in kg
L = length of pile in cm;
A = cross-sectional area of pile in cm\(^2\)
E = elastic modulus of the material of pile in kg/cm\(^2\)
\( T = \) Load on pile top in kg

2.2.2 Calculate the corrected settlement for different load increment by equation (2)
\[ S = mT \]
Where
\( S = \) Corrected settlement in cm,
\( T = \) Total load on pile top in kg

2.2.3 Knowing value of \( m \) and \( S \) compute skin friction and point bearing by solving simultaneous equation (3) and (4).
\[ T = P + F \]
\[ S = \frac{mP + (T - F/2)L}{AE} \]
Where
\( P = \) point bearing in kg,
\( F = \) skin friction in kg.
Test shall be carried out in proper manner and to the entire satisfaction of the Engineer-in-charge. After the test is completed, the test cap shall be dismantled and pile surface shall be restored to original shape.

15.5.3.6 Measurement: Each completed test shall be enumerated for different load ranges.

15.5.3.7 Rate: The rate includes the cost of labour, materials and all the operations described above such as preparatory work, trimming of pile head etc. complete.

15.5.4 Lateral Load Testing

15.5.4.1 Load Platform: A proper loading platform shall be installed as specified. Hydraulic jack is mounted with gauge between two piles or pile groups under test. Dial gauge tips shall rest on central portion of glass plate fixed on the side of pile.

15.5.4.2 Application of Load: Full load imposed by the jack shall be taken as lateral resistance on each pile or group. Load should be applied in increments of about 20% of the estimated safe load. The next increment shall be applied after the rate of displacement is approximately equal to 0.1 mm per 30 minutes.

15.5.4.3 The safe lateral load on pile; is least of the following:
(i) Fifty per cent of the final load at which total displacement increases to 12 mm.
(ii) Final load when total displacement is 5 mm.
(iii) Load corresponding to any other specified displacement as per requirement. Pile group shall be tested as per actual conditions as far as possible.

15.5.4.4 Displacements: Displacement is read by at least two dial gauges of 0.1 mm sensitivity spaced at 30 cm and kept horizontally one above the other and displacement is interpolated at cut off level. One dial gauge placed diametrically opposite to jack shall directly measure displacement. Where, it is not possible to locate one of the dial gauges in the line of the jack axes, then two dial gauge may be kept at a distance of 30 cm at a suitable height and the displacement interpolated at load point from similar triangles.

Note: One of the methods of keeping dial gauge on pile surface is to chip off uneven concrete on the side of the pile and to fix a piece of glass 20 to 30 mm square. The dial gauge tips shall rest on the central portion of the glass plate. Arrangement and test procedure shall be duly approved by the Engineer-in-Charge.

15.5.4.5 Measurement: Each completed test shall be enumerated for different load ranges.

15.5.4.6 Rate: The rate includes the costs of labour, materials and all the operations described above.
Scope
Specification for pile frame shall be in conformity to the one laid in IS 6428. Contractor shall use the proper height of pile frame and which is able to take the weight of hammer safety.

Standard size of pile frame will assist the user in determining the type and size of frame. Damages pile frame which cannot be used for want of spares shall be replaced with sound one.

Size
The size of pile frame shall be designated by its height and the weight of the hammer and the pile it can take.

The pile frame shall be as per the sizes given in table below:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Size</th>
<th>Height of Pile Frame</th>
<th>Weight of hammer</th>
<th>Weight of pile (Any Type) max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>7.5</td>
<td>1.5</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>10.5</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>15</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>20</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>25</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

*Extension Panels:* All pile frames shall be capable of being fixed with extension panels of 1.5, 3 and 4.5 m height without reduction in weight capacity.

Performance: Pile frames with or without extension panels shall be capable of placing piles at the maximum backward rake in 1 in 5 and the maximum forward rake 1 in 10.
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Definition

Bar
It is any solid section, other than round, with at least one dimension of 10 mm or more.

Rod
It is any round solid section with a diameter of 10 mm or greater.

Anodized Aluminum
It is a aluminum with an anodic coating, produced by an electrolytic oxidation process, in which the surface of the aluminum is covered with a coating, generally an oxide, to give protective and decorative properties.

Pre-laminated Particle Board
It is particle board laminated on both surface by synthetic impregnated base papers under the influence of heat and pressure with finished foil under the pressure or pressure and heat depending on type of binder used.

Floor Spring (Hydraulically Regulated)
It is device used to close the door so as to slow down its speed before it reaches its closed position.

Single Action Floor Spring (Hydraulically Regulated)
It is device used to close the door in one direction only so as to slow down its speed before it reaches to its closed position.

Double Action Floor Spring (Hydraulically Regulated)
It is device used to close the door in both directions so as to slow down its speed before it reaches its closed position.

Shoe
The device fixed to the bottom of the door leaf in order to hoist it to the floor spring.

Top Centre Pivot
It is top Centre Pivot is the device to secure the upper portion of the door leaf and the door frame above.

Right Hand Floor Spring
Right Hand Floor Spring is the floor spring suitable for use on an anticlockwise door; an anticlockwise door is one which when viewed from above, rotates in anticlockwise direction about its hinge while opening.

Left Hand Floor Spring
The floor spring suitable for use on clockwise door a clockwise door is one which, when viewed from above, rotates in clockwise direction about its hinge while opening.

Sash
It is a complete window unit whether fixed or open type.

Composite Window
It is a window unit having two or more sashes joined together with one or more coupling members.

Centre - Hung Ventilator
It is a ventilator horizontally pivoted at the centre on both sides. Top half opens inwards and bottom half opens outwards.
16.1 ALUMINIUM
16.1.1 Aluminum Sections
Aluminum sections used for partition, windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in-Charge for technical, structural, functional and visual considerations. The aluminum extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304. The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval, of Engineer-in-Charge and nothing extra shall be paid on this account.

Aluminum glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminum work, with the approval of Engineer-in-Charge

16.1.2 Anodizing
Standard aluminum extrusion sections are available in various shape and sizes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensures uniform coating in uniform colour and shades. The extrusions are anodized up to 30 micron in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard.

16.1.3 Powder Coating

16.1.4 Performance Requirements for the Finish
**Surface appearance:** The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

**Adhesion:** When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

16.1.5 Protection of Powder Coated Al Anodizing Finish: It is mandatory that all aluminum members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

16.1.6 Measurement: All the aluminum sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

16.1.7 Rate: The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification-

16.2 PANELING MATERIAL
16.2.1 Pre-laminated Particle Board
A particles board laminated on both surfaces by synthetic resin impregnated base papers under heat and pressure. Pre-laminated particle boards shall be of two grades, Grade I and II corresponding to IS 3087 & 12823. Each of the grades specified shall be of four types, Types-I, II, III, and IV classified by the surface abrasion characteristics specified in Table 16.1. The grade and types of pre-laminated particle board shall be represented by symbols as follows:-

<table>
<thead>
<tr>
<th>Grade</th>
<th>Type</th>
<th>Designation</th>
</tr>
</thead>
</table>

412
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Properties</th>
<th>Flat Pressed Three Layer, Multilayer and Graded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Grade-I</td>
</tr>
<tr>
<td>(i)</td>
<td>Density variation (Max.) Percent</td>
<td>±10</td>
</tr>
<tr>
<td>(ii)</td>
<td>Water absorption (Max)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) 2 hours</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>(b) 24 hours</td>
<td>15.0</td>
</tr>
<tr>
<td>(iii)</td>
<td>Thickness swelling (Max.), percent, 2 hours</td>
<td>5.0</td>
</tr>
<tr>
<td>(IV)</td>
<td>Modulus of rupture (Min) N/mm²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Up to 20 mm thickness</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>(b) Above 20 mm thickness</td>
<td>12.5</td>
</tr>
<tr>
<td>(V)</td>
<td>Tensile strength perpendicular to surface (Min.) N/mm²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Up to 20 mm thickness</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(b) Above 20 mm thickness</td>
<td>0.40</td>
</tr>
<tr>
<td>(vi)</td>
<td>Tensile strength perpendicular to surface (Min.) N/mm²</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) After cyclic test*</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>(b) After accelerated water resistance test**</td>
<td>0.15</td>
</tr>
<tr>
<td>(vii)</td>
<td>Screw withdrawal strength (Min.), N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Face</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td>(b) Edge</td>
<td>850</td>
</tr>
<tr>
<td>(viii)</td>
<td>Abrasion resistance (Min.) in number of revolutions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Type I</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>(b) Type II</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>(c) Type III</td>
<td>80</td>
</tr>
</tbody>
</table>

Note: * Cyclic Test: Specimen are immersed in water at 27±2° C for a period of 72 hours, followed by drying in air at 27 ± 2° C for 24 hours and then heating in dry air at 70° C for 72 hours. Three such cycles are to be followed and then specimens are tested for tensile strength perpendicular to the surface.

** Accelerated Water Resistance Test: Specimens are immersed in water at 27±2° C and water is brought to boiling and kept at boiling temperature for two hours. Specimens are then cooled in water to 27±2° C and tested for tensile strength perpendicular to the surface.

(a) **Particle Board:** Synthetic resin bonded flat pressed three layers; multilayer and graded particle board defined in IS 3087 having superfine surface shall be used for production of prelaminated particle board. For ECO Marks the particle board shall also conform to the requirements of ECO Mark specified in IS 3087.

(b) **Impregnated Base Paper:** Printed or plain coloured absorbent base paper having a weight of 62 to 140 g/m² impregnated in a suitable synthetic resin and dried to a volatile content of 4 to 8 per cent shall be used for pre-lamination on both surfaces of particle board.

(c) **Impregnated Overlay:** An absorbent tissue, paper having a weight of 18 to 40 g/m² impregnated in a suitable synthetic resin and dried to a volatile content of 4 to 8 per cent shall be used for the manufacture of pre-laminated particle board.
(d) **Manufacture:** Particle boards having superfine and closed surface with high face strength and steep density gradient across the thickness is used for making prelaminated particle boards. Impregnated base papers rich in a synthetic resin are placed on either side of the particle board and the assembly is taken inside a short cycle single opening lamination press or a multi day light press. Under heat and pressure the resin flows and forms a permanent bond with particle board. The top surface of impregnated paper comes in contact with special surface chromium plates or steel cauls plates and takes the impression of surface finish of these cauls. Hot boards are extracted out of the short cycle press and cooled in air, whereas cooling of boards is done inside the dress in multiday light type. Care should be taken to keep cycle times low in the press to avoid heat penetration to the centre of the board edge. The impregnated overlay paper may be used by placing it over the impregnated base paper (IBP) on one surface while using a normal IBP on the other surface and pressure. The impregnated overlay becomes transparent after pressing. Such boards are used for high surface abrasion application.

In case of finished foil particle boards, the finished foil is pasted on both surfaces of particle board after spreading suitable synthetic glue on board’s surface and passing the assembly in a roller press or a flat press under the influence of pressure and/or heat depending on the type of binder used.

(e) **Finish:** The finish of the paper overlaid board depends on the surface of cauls plates used. Common surface finishes in use are glossy, matt textured (soft, Swede, wood pore and leather), etc, the surface finish of the foil finished boards depends on the original finish of the foil used.

(f) **Dimensions and Tolerances:** Dimensions and tolerances shall conform to IS 12049.

(g) **Testing:** One sample for every 100 sqm. or part thereof shall be taken and testing done as per IS 12823. For quantity less than 100 sqm, the test certificate from manufacturer shall be relied upon. The Engineer-in-charge may ask for testing even if the quantity is less than 100 sqm.

### 16.2.2 Aluminum Sheet

(a) Aluminum Sheets for use as panels shall be 1.25 mm thick aluminum alloy sheet conforming to IS 737. Aluminum alloy sheet for use in general paneling work shall be of types and thickness as specified and conforming to the requirement of IS 737. Aluminum sheets shall be of approved make and manufacturer. Aluminum panel may be prefabricated units manufactured on modular or non-modular dimension.

(b) **Fixing:** The required size of panel, keeping sufficient margin to be inserted inside the section, shall be cut to correct size and fixed firmly in the frame with CP brass or aluminum or stainless steel screws of star headed, counter sunk and matching size groove. Joints sealed with epoxy resin or silicon sealant to make the unit water proof.

### 16.2.3 Float Glass

(a) The float glass shall conform to the IS 14900. The glass shall be clear float glass and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable defects.

(b) **Thickness:** The thickness of float glass shall depend on the size of panel. The tolerance in thickness shall be as under:

<table>
<thead>
<tr>
<th>Nominal Thickness (in mm)</th>
<th>Tolerance (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>±0.3</td>
</tr>
<tr>
<td>5.0</td>
<td>±0.3</td>
</tr>
<tr>
<td>6.0</td>
<td>±0.3</td>
</tr>
<tr>
<td>8.0</td>
<td>±0.6</td>
</tr>
</tbody>
</table>
(c) **Allowable Defects**: The allowable defects shall be as per Table 16.3 below:

<table>
<thead>
<tr>
<th>S/. No.</th>
<th>Defects</th>
<th>Central</th>
<th>Outer</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Gaseous inclusion. Max size. mm</td>
<td>3.0</td>
<td>6.0</td>
<td>Separated by at least 30.0 cm</td>
</tr>
<tr>
<td>2.</td>
<td>Opaque gaseous inclusion. Max size. mm</td>
<td>3.0</td>
<td>6.0</td>
<td>Separated by at least 60.0 cm</td>
</tr>
<tr>
<td>3.</td>
<td>Knots, dirt and stones, Max size. mm</td>
<td>1.0</td>
<td>1.0</td>
<td>Separated by at least 30.0 cm</td>
</tr>
<tr>
<td>4.</td>
<td>Scratches, Rubs and Crush</td>
<td>Faint</td>
<td>Light</td>
<td>Separated by at least 30.0 cm</td>
</tr>
<tr>
<td>5.</td>
<td>Bow, percent. Max</td>
<td>0.50</td>
<td>0.50</td>
<td>See 16.2.c</td>
</tr>
<tr>
<td>6.</td>
<td>Reams, Strings and lines</td>
<td>Light</td>
<td>Light</td>
<td>See 16.2.d</td>
</tr>
<tr>
<td>7.</td>
<td>Waviness</td>
<td>Nil</td>
<td>Nil</td>
<td>See 16.2.e</td>
</tr>
<tr>
<td>8.</td>
<td>Sulphur stains</td>
<td>Nil</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Corner breakage and chip</td>
<td>Not more than nominal thickness of float glass</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(d) **Allowable Cluster of Defects**: The allowable cluster of defects mentioned under SI No. 1, 2 & 3 of Table 16.3 shall be as per IS 14900.

### 16.2.4 Tests

(a) **Thickness**: The thickness of float glass shall be measured with micrometers or a caliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.

(b) **Scratches, Rubs and Crush**: Place the sample of float position approximately 50 cm from the viewer’s position and look through it using either day light without direct sunlight or a background light suitable for observing each type of defect.

<table>
<thead>
<tr>
<th>Intensity of Scratches, Rubs, Crush</th>
<th>Intensity Distance Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faint</td>
<td>Shall not be detectable beyond 50 cm</td>
</tr>
<tr>
<td>Light</td>
<td>Detectable between 50-100 cm and not beyond 100 cm.</td>
</tr>
</tbody>
</table>

(c) **Bow**: Depending on the side on which bow is present, stand the sample vertically on a wooden plank. Stretch a thread edge to edge. Measure the longest perpendicular. Distance from the thread to the surface of float glass facing the thread and express it as percentage of the length of float glass from edge along the thread.

(d) **Reams, Strings and Lines**: Focus a fight projector with a 500 W lamp and an objective lens with an approximate 5 cm aperture and about 30 cm focal length on a flat white projection screen placed about 760 cm from the light source in a dark room. Place the float glass in a vertical position parallel to the screen between the light and the screen. Move the glass slowly towards the screen with a vertical oscillating motion. The shadowgraph read out is the distance at which the distortion just blends with the general shadow of the glass on the screen.

<table>
<thead>
<tr>
<th>Intensity of Reams, Strings and Lines</th>
<th>Intensity Distance Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>7.5 cm</td>
</tr>
<tr>
<td>Medium</td>
<td>5.0 cm</td>
</tr>
<tr>
<td>Heavy</td>
<td>2.5 cm</td>
</tr>
</tbody>
</table>
(e) **Perspective Distortion**: When tested as per test procedure described below it shall not give distorted vision of straight stripe pattern.

**Test Procedure for Perspective Distortion**
Perspective distortion shall be examined by looking through the specimen glass which may be placed at about 4.5 m distance in such a direction that the incident angle to it is 50 degree (4 mm or above) and by observing a screen set up perpendicularly to the line of vision about 4.5 m further ahead of the specimen over the total width of about middle part of the specimen from the horizontal direction. The specimen glass shall be kept with the drawn direction at manufacture vertical and, on the surface of the screen, the strip pattern of white and black parallel straight lines of 25 mm width and inclined 45 degrees from the vertical shall be provided and its surface shall be luster less.

### 16.3 EPDM-GASKETS
The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer-in-Charge shall only be used. The contractor shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge. The EPDM gasket shall meet the requirements as given in Table below:

<table>
<thead>
<tr>
<th>S/. No.</th>
<th>Description</th>
<th>Standard Follow</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tensile strength Kg.f/cm²</td>
<td>ASTM-D412</td>
<td>70 Min.</td>
</tr>
<tr>
<td>2</td>
<td>Elongation at break %</td>
<td>ASTM-D412</td>
<td>250 Min.</td>
</tr>
<tr>
<td>3</td>
<td>Modulus 100% Kg/cm²</td>
<td>ASTM-D412</td>
<td>22 Min.</td>
</tr>
<tr>
<td>4</td>
<td>Compression set % at 0° CC 22 Hrs.</td>
<td>ASTM-D 395</td>
<td>50 Max.</td>
</tr>
<tr>
<td>5</td>
<td>Ozone resistance</td>
<td>ASTM-D 1149</td>
<td>No visible cracks</td>
</tr>
</tbody>
</table>

### 16.4 SEALANT
(a) The sealants of approved grade and colour shall only be used. The silicone for perimeter joints (between Aluminum section and RCC/Stone masonry) shall be of make approved by the Engineer in Charge.

(b) **Method of Application**

**Surface Preparation**: Clean all joints and glazing pockets by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.

(c) **Masking**
Areas adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall not be allowed to touch clean surfaces to which the silicone sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

(d) **Application**
Install backer rod of appropriate size and apply silicone sealant in a continuous operation using a positive pressure adequate to properly fill and seal the joint. The silicone sealant shall be tooled with light pressure to spread the sealant against backing material and the joint surfaces before a skin forms; a tool with convex profile shall be used to keep the sealant within the joint. Soap or water shall not be used as a tooling aid. Remove masking tape as soon as silicone joint is tooled.

(e) **Tolerance**: A tolerance of + 3 mm shall be allowed in the width of silicone joints. The depth of the joints at throat shall not be less than 6 mm.

### 16.5 REFLECTIVE GLASS
#### 16.5.1 Definitions
(i) **Shading Coefficient**: The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.
(ii) **Luminous Efficacy Constant** \((Ke)\) indicates a window's relative performance in rejecting solar heat while transmitting daylight. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar near-infrared energy has a \(Ke\) close to 1.0. The solar radiation contains about 50% invisible near-infrared & ultraviolet light. Therefore, a perfectly selective glazing, which would allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have \(Ke\) of about 2.0.

(iii) **Resistance to Heat Conduction** \((R\text{-valve})\): It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of \(R\)-value is termed as \(U\)-value.

**16.5.2 Reflective Glass**
This is a float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass, i.e. reflective glass, has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks daylight more than solar heat.

(a) **Types of Coatings**:
(i) **Pyrolitic (Hard) coated**: It is a coating applied during glass manufacture. The coating is fused into the glass at 1200°C.

(ii) **Vacuum (Soft) Coated Glass**: It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than pyrolitic products.

(b) **Performance of Reflective Glass**: The performance of reflective glass 6 mm of nominal thickness is given below:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Parameter</th>
<th>Threshold Ratio In %age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Visible Light : - Transmittance (%) - Reflectance (%)</td>
<td>15-46 12-24</td>
</tr>
<tr>
<td>2.</td>
<td>Total Solar Energy: - Transmittance (%) - Reflectance (%)</td>
<td>16-24 8-12</td>
</tr>
<tr>
<td>3.</td>
<td>Ultra Violet Rays; - Transmittance (%)</td>
<td>2-10</td>
</tr>
<tr>
<td>4.</td>
<td>U-Value - Summer - Winter</td>
<td>0.58 0.45</td>
</tr>
<tr>
<td>5.</td>
<td>Shading Coefficient</td>
<td>0.25-0.35</td>
</tr>
</tbody>
</table>

(c) **Testing**: The reflective glass shall be tested for the followings:
(i) **Physical/Field Test**: In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.

(ii) **Lab. Test**: In the lab, the reflective glass shall be tested for the parameter specified in para 16.5.2.b above.

(d) Fixing of glass shall be done as specified.

**16.6 DOOR, WINDOW, VENTILATOR AND PARTITION FRAMES**

**16.6.1 Framework**
First of all the shop drawings for each type of doors/windows/ventilators etc. (Showing full size sections of glazed doors, windows, ventilators etc) shall be prepared. The shop drawings shall also show the details of fittings, Joints and prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminum sections being extruded by approved manufacturers. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge.
Before fabrication actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered Joints shall be corner crimped or fixed with self tapping stainless steel screws using extruded aluminum cleats of required length and profile. All aluminum work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

16.6.2 Fixing of Frames
The holes in concrete/masonry/wood/any other members for fixing anchor bolts/fasteners/screws shall be drilled with suitable electric drill. Windows/doors/ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed. Counter sunk and matching size groove, of required size at spacing not more than 25cm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Engineer-in-Charge in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap headings and EPDM gasket shall be fixed as per the detail shown in the approved shop drawings. Where aluminum comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to save from electrochemical corrosion is, insulation material shall be trimmed off, to a clean flush line on completion.

The contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

16.6.3 Measurements
All the aluminum sections including snap headings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

16.6.4 Rate
The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

16.7 DOOR, WINDOWS AND VENTILATOR SHUTTERS
Material, fabrication and dimensions of aluminum doors, windows and ventilators manufactured from extruded aluminum alloy sections of standard sizes and designs complete with fittings, ready for being fixed into the building shall be as per IS 1948.

16.7.1 Terminology
The components of doors, windows and ventilators shall be defined as in Figure No.1 below.
16.7.2 Standard Sizes, Tolerances and Designations
The types and the overall sizes of aluminum doors, windows and ventilators shall be as given in Figure No. 2. Their sizes are derived after allowing 1.25 mm clearances on all the four sides for the purpose of fitting the doors, windows and ventilators into modular openings.
Note: 1. Windows without horizontal glazing bars shall be designated by 'N' in place of 'H' in the range shown.

2. Doors and side lights shall only be coupled with 12 module (117.5cm) high windows.
All dimensions in centimeters and not to scale

Fig 2: Types and Size of Aluminum Doors, Windows and Ventilators.

16.7.3 Tolerances
The sizes for doors, windows and ventilators frames shall not vary by more than ±1.5 mm.

16.7.4 Glass Panels
Glass panels shall weigh at least 7.5 kg/m² and shall be free from flaws, specks or bubbles. All panels shall have properly squared corners and straight edges. The sizes of glass panels for use in doors, windows and ventilators shall be as given in Table 16.6.
### TABLE 16.6
Glass Sizes (Clearance Allowed)

<table>
<thead>
<tr>
<th>Designation</th>
<th>Quantity</th>
<th>Glass size Width X Height cm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Glazing Bar Centre-Hung Type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6NC6</td>
<td>1</td>
<td>46.0x46.0</td>
</tr>
<tr>
<td>10NC6</td>
<td>2</td>
<td>42.5x46.0</td>
</tr>
<tr>
<td>12NC6</td>
<td>2</td>
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<td>4</td>
<td>66.0x27.5</td>
</tr>
<tr>
<td></td>
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<td>56.0x27.5</td>
</tr>
<tr>
<td>12HS21</td>
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<tr>
<td></td>
<td>9</td>
<td>50.5x27.5</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>40.5x27.5</td>
</tr>
</tbody>
</table>
16.7.5 Screws
Screws threads of machine screws used in the fabrication of aluminium doors, windows and ventilators shall conform to IS 1362.

16.7.6 Fabrication
Frames: Frames shall be square and flat, the corners of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections which have been cut to length, mitered and welded at the corners. Where hollow sections are used with welded joints, argon-arc welding or flash butt welding shall be employed (gas welding or brazing not to be done). Subdividing bars of units shall be tenoned and riveted into the frame.

16.7.7 Side-hung Shutters
For fixing aluminum alloy hinges, slots shall be cut in the fixed frame and the hinges inserted inside and may be riveted to the frame. The hinges shall normally be of the projecting type 67 mm wide (FIG-3). The aluminum alloy for cast hinges shall conform to IS Designation A-5-M of IS 617. Specification for Aluminum and Aluminum Alloy Ingots and Castings for General Engineering Purpose and for extruded section of hinges to IS Designation HE10-WP or HE30-WP of IS 733. The pins for hinges shall be of stainless steel of non-magnetic type or aluminum alloy HR30. Irrespective of hinges being anodized or not, the aluminum alloy pins shall be anodized to a minimum film thickness of 0.025 mm shall be sealed with oil, wax or lanolin. Non-projecting types of hinges may also be used where ever required. (FIG-4). Friction hinges may be provided for side-hung shutter windows, in which case peg stay may not be required. The working principle of the friction hinges is illustrated. (FIG-5).

The handle for side-hung shutters shall be of cast aluminum conforming to IS Designation A-5-M of IS 617 and mounted on a handle plate welded or riveted to the opening frame in such a way that it could be fixed before the shutter is glazed. The handle should have anodized finish with minimum anodic film thickness of 0.015 mm. The handle shall have a two points nose which shall engage with an aluminum striking plate on the fixed frame in a slightly open position as well as in a fast position (FIG-6). The height of the handles in each type of side-hung shutters shall be fixed in approximate position as indicated. (FIG-H).
The peg stay shall be either of cast aluminum conforming to IS 617 or folded from IS Designation N84 aluminum alloy sheet conforming to IS: 737 specifications for wrought aluminum and aluminum alloys, Sheet and strip. It shall be 300 mm long, complete with peg and locking brackets (Fig. 1). The stay shall have holes for keeping the shutter open in three different positions. The peg and locking bracket shall be riveted or welded to the fixed frame.

Alternatively, and if specifically required by the purchaser, side-hung shutters may be fitted with an internal removable fly screen of 0.375 mm wire and equivalent to IS Sieve 100 in a 0.900 mm aluminum alloy sheet conforming to IS Designation NS3-1/2H of IS 737 applied to the outer frame of the shutter by case or extruded aluminum alloy turn-buckie at the jambs and by aluminum or plated bronze shoes at the sill to allow of the screen being readily removed, and with a rotor operator at the sill to permit the operation of the shutter through an angle of 90°. On fly-screened shutters the peg stay is omitted and the normal handle

The aluminum hinges for top-hung ventilators shall be either cast or fabricated out of extruded sections and shall be riveted to the fixed rail after cutting a slot in it. The aluminum alloy for cast hinges shall
conform to IS Designation A-5-M of IS 617 and the extruded section of hinge to IS Designation HE10-WP or HE30J/VP of IS 733
The pegs stay shall be 300 mm long as in side-hung shutter, The locking bracket shall be fixed to the fixed frame.

16.7.8 Centre-Hung Ventilators Centre hung ventilators shall be hung on two pairs of cup pivots of aluminum alloy to IS Designation NS-4 of IS 737 and IS Designation A-5-M of IS 617 or on brass or bronze cup pivots which should be either chromium or cadmium plated and riveted to the inner and outer frames of the ventilators to permit the ventilator to swing through an angle of approximately 85°.
The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather condition.
Cast aluminum conforming to IS Designation A-5-M of IS 617 or bronze which shall be either chromium-plated or cadmium-plated spring catch shall be fitted in the centre of the top bar of the ventilators for the operation of the ventilator. This spring catch shall be secured to the frame and shall close into aluminum catch plate riveted or welded to the outside of the outer ventilator frame bar.
Aluminum or cadmium plated brass cord pulley-wheel in an aluminum bracket shall be fitted at the sill of the ventilator with aluminum or galvanized or cadmium plated steel screw or, alternatively, welded together with an aluminum cord eye riveted or welded to the bottom inner frame bar of the ventilator in a position corresponding to that of pulley

16.7.9 Doors
The kick panels shall be of 1.25 mm aluminum alloy sheet conforming to IS Designation NS3-1/2H of IS 737 specification for Wrought Aluminum and Aluminum Alloys, Sheet and strip and shall be screwed to the frame and the glazing bar.

*Hinges* - Cast of extruded aluminum alloy hinges for doors shall be of the same type as in the windows but of larger size. The hinges shall normally be of the 50 mm projecting type. Non-projecting type of hinges may also be used.
The handle for doors may be of the design indicated in.
A suitable lock for the door operable either from inside or outside shall be provided.

Note: From the point of view of security, the lock which is operable from only one side is better and in the case of such locks, a bolt shall be provided to make them inoperable from the other side.

**Typical Door Handle**

In double shutter doors the first closing shutter shall have a concealed aluminum alloy bolt at top and bottom. It shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter doors may be provided with a three-way bolting device Where this is provided in the case of double shutter door, concealed aluminum bolts may not be provided.

**16.7.10 Composite Units**
The doors shall be coupled to windows or side-lights by extruded aluminum sections made from aluminum alloy conforming to IS Designation HE9-WP of IS 733. The coupling member should conform to the dimensions indicated in Fig.

![Fig. J : Coupling Section Extruded for Coupling Door to Window or Side Light](image-url)
16.7.11 Weather Bar
Where a coupling member is fitted over an external opening shutter, the coupling member should incorporate an integrally extruded weather bar.

16.7.12 Position of Bolts, Fixing Screws and Lugs
Outer frames shall be provided with fixing holes centrally in the web of the sections in the position Moreover, any steel lugs coming in contact with aluminum should be either galvanized or given one coat of bituminous paint.

The fixing screws and lugs shall be as given in Table 16.7

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Place of Fixing</th>
<th>Size of Screw or Lug</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>To wooden frames rebated on the outside</td>
<td>30 mm x No. 10 galvanized wood-screws.</td>
</tr>
<tr>
<td>(ii)</td>
<td>To plugs in concrete, stone or brick work rebated on the outside</td>
<td>-Do-</td>
</tr>
<tr>
<td>(iii)</td>
<td>To plugs in concrete, stone or brick work not rebated on the outside (that is plain or square jambs)</td>
<td>45 mm X No. galvanized wood-screws</td>
</tr>
<tr>
<td>(IV)</td>
<td>Direct to brick work or masonry (that is plain or square jambs)</td>
<td>Slotted steel adjustable lugs (natural finish) not less than 100 x 16 x 3 mm countersunk galvanized machine screws and nuts 19.0 X 6.3 mm</td>
</tr>
<tr>
<td>(V)</td>
<td>To steel work</td>
<td>Standard clips and 8 mm galvanized bolts with hexagonal nuts.</td>
</tr>
</tbody>
</table>

16.7.13 Finish
Aluminum doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally, also be anodized, if so required by the Engineer-in-charge. If colour anodizing is to be done then only approved light-fast shades should be used.

A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate, shall be applied on aluminum doors, windows and ventilators by the supplier to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is completed.

16.7.14 Glazing
Glazing shall be provided on the outside of the frames
If required, glazing clips may be provided as extra fittings. Four glazing clips may be provided per glass pane, except for door type 8HS21 where the glazing clips shall be six per glass pane. In case of doors, windows and ventilators without horizontal glazing bars the glazing clips shall be spaced according to the slots in the vertical members, otherwise the spacing shall be 30 cm.

Note: Glazing clips are not usually provided for normal size glass panes. Where large size glass panes are required to be used or where the door or the window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stage. Use of glazing clips, where necessary, shall be specified while placing the order.

16.7.15 Packing
All doors, windows and ventilators shall be dispatched with the opening parts suitably secured to preserve alignment when fixing and glazing.
Fixing lugs, coupling fittings and all hardware shall be dispatched separately. Composite windows shall be dispatched uncoupled.

16.7.16 Marking
All doors, windows and ventilators shall be suitably marked on the frames with a mark identifying the manufacturer and the type. The units may also be marked with the BIS Certification Mark.
16.8 FITTINGS

16.8.1 Stainless Steel Friction Stay
The stainless steel friction stays of make and approved by the Engineer-in-Charge shall be used. These stays shall be of grade AISI-304 and of sizes specified in nomenclature of item.

16.8.2 Lockable Handles
The lockable handle shall be of make and approved by the Engineer-in-Charge and of required colour to match the colour of powder coated/anodized aluminum window sections.

16.8.3 Hydraulic Floor Spring
The hydraulic floor spring shall be heavy duty double action floor spring of make approved by the Engineer-in-Charge suitable for door leaf of weight minimum 100 kg. The top cover plate shall be of stainless steel, flushing with floor finish level. The contractor shall cut the floor properly with stone cutting machine to exact size & shape. The spindle of suitable length to accommodate the floor finish shall be used. The contractor shall give the guarantee duly supported by the company for proper functioning of floor spring at least for 10 years.

16.8.4 Tubular Handle
The tubular handle bar shall be aluminum polyester powder coated minimum 50 micron to required colour/anodized AC 15. Outer dia of tube shall be 32 mm, tube thickness 3.0 mm and centre to centre length 2115 mm ± 5 mm.

16.8.5 Measurement
Refer Para 16.6.3.

16.8.6 Rate
Refer Para 16.6.4.

16.9 LOUVERS
Aluminum extruded sections (anodized or power coated) are used for providing Louvers in aluminum door, window & partition for ventilation.

16.9.1 Fabrication
Refer Para 16.6.1.

16.9.2 Measurements
Refer Para 16.6.3.

16.9.3 Rate
Refer Para 16.6.4.

16.10 HERMETICALLY SEALED UNIT
Insulating glass shall be a double glazed unit comprising two sheets of float glass panes separated by a spacer, hermetically sealed using primary and secondary sealants. The design of insulating glass system shall consist of:

(a) Hollow Spacer Bar
The hollow aluminum spacer bar shall be of required size and shape and shall be colour anodized. The spacer bar shall have two lines of perforations in the inner surface.

(b) Desiccant
The desiccant shall be Neftomol 3 A Chemetall or equivalent. The desiccant filled in the aluminum spacer bar shall be synthesized crystalline compounds of Aluminum Hydroxide, Caustic Soda and Sodium Silicate which absorbs water molecules. The desiccant shall be of 3 A sizes (A means Angstrom). The quantity of desiccant used shall not be less than 35 gm/m length of spacer bar. Filled spacer bar frame shall not be stored for more than 6 hours before assembly and sealing of the unit to ensure proper functioning of the desiccant. The contractor shall submit documentary proof of using the above material in the work.
(c) Primary Sealant
The primary sealant shall be single component approved by the Engineer in Charge, thermo plastic solvent free sealing compound based on polysosutylene. The sealant surface shall be free from cavities, depression and other defects. The contractor shall submit documentary proof of using the above material in this work.

(d) Secondary Sealant
The secondary sealant in double glazed unit shall be silicone sealant approved by the Engineer in Charge. The contractor shall submit documentary proof of using the above material in this work to the entire satisfaction of Engineer-in-Charge. Before application of silicone/ polysulphide, the surface must be cleaned and free from oil, grease, dust and other loose matter. The surfaces shall be cleaned with alcohol or other suitable solvents. Detergent or soap shall not be used to clean the surfaces. The polysulphide shall be mixed and applied mechanically using automatic mixing machine in the manner approved by Engineer-in-Charge.

Measurement
The height and width of double glazed/single glazed unit (the area of glass unit outside the snap beading shall only be measured) as fixed in place shall be measured correct to one centimeter and area calculated in sqm. correct to second place of decimal shall be taken for payment.

Rate
The rate shall include the cost of all the materials, labors involved in all the operations as described in nomenclature of item and particular specification.

16.11 BRASS LOCK
This should generally conform to IS-2209. The size of the lock shall be denoted by the length of the body towards the face and it shall be 100 mm. the measured length shall not vary more than 3 mm from the specified length. Ordinary lever mechanism with not less than 2 levers shall be provided. False lever shall not be used. Lever shall be fitted with one spring of phosphor-bronze or steel wire and shall withstand the test as provided in IS-2209. Locking-bolt spring and strike plate shall conform to IS 2209. Two keys shall be provided with each lock.
**LIST OF BUREAU OF INDIAN STANDARD (BIS) CODES**

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<th>Subject</th>
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<td>IS 73</td>
<td>Wrought Aluminum and Aluminum Alloys, Bars, Rods and Sections (For General Engineering Purposes) Specification</td>
</tr>
<tr>
<td>2.</td>
<td>IS 737</td>
<td>Wrought Aluminum and Aluminum alloy sheet and strip for general engineering purposes - Specification</td>
</tr>
<tr>
<td>3.</td>
<td>IS 1285</td>
<td>Wrought Aluminum and Aluminum Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) - Specification</td>
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<td>4.</td>
<td>IS 1868</td>
<td>Anodic coating on Aluminum and its Alloys - Specification</td>
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<td>5.</td>
<td>IS 1948</td>
<td>Specification for Aluminum Doors, Windows and Ventilators</td>
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<tr>
<td>6.</td>
<td>IS 3908</td>
<td>Specification for Aluminum, equal leg angles</td>
</tr>
<tr>
<td>7.</td>
<td>IS 3909</td>
<td>Specification for Aluminum unequal leg angles</td>
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<td>8.</td>
<td>IS 3965</td>
<td>Dimensions for wrought Aluminum and Aluminum Alloys bars, rods and sections.</td>
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<td>9.</td>
<td>IS 5523</td>
<td>Method of testing anodic coating on aluminum and its alloys.</td>
</tr>
<tr>
<td>10.</td>
<td>IS 6012</td>
<td>Measurement of coating thickness by Eddy Current Method</td>
</tr>
<tr>
<td>11.</td>
<td>IS 6315</td>
<td>Floor springs (Hydraulically regulated) for heavy doors - Specifications</td>
</tr>
<tr>
<td>12.</td>
<td>IS 6477</td>
<td>Dimensions of extruded hollow section and tolerances</td>
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<td>13.</td>
<td>IS 12823</td>
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<td>14.</td>
<td>IS 14900</td>
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17. WATER PROOFING TREATMENT
## Contents

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<td>17.8 to 17.8.8</td>
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<tr>
<td>17.9 to 17.9.6</td>
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<td>17.10 to 17.10.6</td>
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<td>Five layered water proofing treatment with atactic poly propylene polymer modified pre-fabricated membrane, materials, preparation of surface, treatment laying, Measurement and rate.</td>
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<td>List of Bureau of Indian Standard Codes.</td>
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Definitions

**Water Bars:** These are preformed strips of impermeable materials which are embedded in the concrete during construction.

**Low Partition Walls:** These are the parapet walls of height less than 45 cm.

**Expansion Joints:** The joints provided in the structure to allow for thermal expansion or construction.

**Blended Cement:** The cement mixed with water proofing compound in liquid or powder form.

17.1 INTEGRAL CEMENT BASED TREATMENT FOR WATER PROOFING ON HORIZONTAL SURFACE OF UNDERGROUND STRUCTURE AT ALL DEPTH

17.1.1 Water Proofing of Horizontal Internal Surfaces of Underground Structure (Fig. 1)

(a) **Preparation of Surface:** Surface for water proofing may be leveling curse or lean concrete. The water proofing treatment should adhere to the surface therefore surface proposed for water proofing treatment should be roughened properly when the concrete is still green. In case the surface is not made rough before the concrete is set, the work of water proofing should not be executed till proper key is provided for the base layer of Cement Mortar 1:3.

![Figure 1: Waterproofing of Horizontal Surface of U.G. Structure](image)

(b) **Blending Cement/Water with Water Proofing Compound:** The required quantity of cement bags to be used for a particular portion of work should be emptied on a dry platform. Water proofing compound bearing ISI mark and conforming to IS 2645 should then be mixed properly with the cement. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement. The quantity of cement and water proofing compound thus mixed should be thoroughly blended and the blended cement should again be packed in bags. For the water proofing compound in liquid form, the blending is to be done with water. This can be done by taking the just required quantity of water to be mixed in the particular batch of dry cement mortar. The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water proofing compound from sealed tins with ISI mark. The water thus mixed with water proofing compound shall be thoroughly stirred so that the water is blended with water proofing compound properly.

(c) **Rough Kota Stone 22 to 25 mm Thick:** For this item the stone slabs in thickness of 22 mm to 25 mm shall be used. To minimize number of joints the larger size of stone slabs i.e. 550 mm x 550 mm or 550 mm x 850 mm shall be used. The specification shall be as follows UADD specifications of Kota Stone flooring.

(d) **Preparation of Cement Slurry** Cement slurry shall be prepared by using 2.2 kg of blended cement/sqm. Area. Each time only that much quantity shall be prepared which can be covered on the surface and the surface in turn would be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained unused for more than half an hour shall be totally rejected.

(e) **Preparation of Cement Mortar** Cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be prepared with cement/ water duly blended as explained in para 17.1.1 (b). Only that much quantity of cement mortar which can be
consumed within half an hour, shall be prepared. Any cement mortar that is prepared and remains unused for more than half an hour shall not be used in the work and shall be rejected.

(f) Laying Water Proofing Course

Before laying the base course of cement mortar 1:3, the lean concrete surface shall be cleaned neatly with water. Cement slurry prepared as per para 17.1.1 (b), shall be applied only on the area of the concrete surface, that can be covered, with the cement mortar (1:3) base course within half an hour. The cement slurry should cover every spot of the surface and no place shall remain uncovered. Just after the application of cement slurry on the surface, the cement mortar prepared as per para 17.1.1 (c) should be used for laying the base course. Base Course should be laid to a perfect level with wooden/aluminum straight edge of at least 2 mtrs. Long. The top surface of cement mortar should be finished neatly and later scratched when green with a suitable instrument before the base course dries and gets hard that is Just before the base course takes up initial set. When the 25 mm thick base course is just getting set the cement slurry prepared as per para 17.1.1 (d) should be spread over the base course upto the area that shall be covered with just two to three stone slabs. The cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap or dry spots. Immediately on applying cement slurry on the base course the Rough Kota Stone slab shall be laid over the base course and pressed gently so that the air gap can be removed. The slurry applied on the surface which gets spread when the stone slab is pressed shall get accumulated in the joints of adjacent stone slabs and if any gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry. For laying the stone slabs in perfect level, two stone slabs at adjacent concerns/ends shall be fixed firmly to the required level and a string stretched over the two slabs, the intermediate slabs shall then be set to the level of the string. After filling all the joints of the Rough Kota stone Slabs with cement slurry the area of stone slab shall be laid with cement mortar 1:3. The surface of stone slabs shall be cleaned and lightly watered. Cement mortar 1:3 prepared as per para 17.1.1 (d) shall be used for laying this course. For laying this course 25 mm high wooden strips shall be used and the top surface shall be finished smooth without using additional cement or slurry.

After laying 3rd course and before the mortar layer takes the initial set, Stone aggregate of 10 mm to 12 mm nominal size shall be uniformly spread and lightly pressed into the finished surface @ 8 cudm. /sqm. The aggregates shall not be embedded totally inside the mortar and shall be visible on the top surface. In cases where slope is to be provided for the water proofing layer, grading with additional cement concrete/cement mortar shall be provided and then the water proofing layer shall be laid on the graded surface. Extra payment shall however be made for the grading course.

(g) Curing

Immediately after completing the fourth layer, arrangements shall be made for the top RCC slab as quickly as possible and in the mean time till the top slab is casted the water proofing treatment shall be kept wet continuously. In case the concreting of slab gets delayed for more than two weeks the curing can be stopped after 14 days.

(h) Measurement

Length and breadth shall be measured along the finished surface correct to a cm and the area shall be worked out to the nearest 0.01 sqm.

(i) Rate

The rate shall include the cost of all labour & materials involved in all the operations described above. The cost of grading with cement concrete / cement mortar shall be paid for separately.

17.1.2 Water Proofing of Internal Horizontal Surfaces of Under-ground Structure (Fig. 2)

Same as in para 17.1.1 above except that water proofing courses will be laid on R.C.C. Slab.
17.2 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT ON THE VERTICAL SURFACE OF UNDER GROUND STRUCTURES

(a) Preparing the Surface
The surface of the structure to be treated shall be roughed either by raking of Joints in case of brick/stone masonry or by hacking the cement concrete surface with a specifically made hacking tool just after removing shuttering. Alternately, the surface should be roughened by providing spatter dash key as explained. While doing water proofing to vertical faces from inside, it shall be ensured that water proofing treatment of floor slab is not damaged. Preferably, water proofing of vertical surface shall be done before that of horizontal surface.

(b) Blending Cement/Water with Water Proofing Compound, Rough Kota Stone Slab, Preparation of Cement Slurry, and Preparation of Cement Mortar
Same as specified under para 17.1.1 (b) To 17.1.1. (e) Are applicable.

(c) Laying Water Proofing Course
Same as specified under para 17.1.1(f). Further rough Kota stone are not sufficiently rough to remain in vertical position held by cement slurry. Therefore, the grip for the stone slab has to be increased and this can be done by planting 12 mm to 15 mm nominal size stone aggregate fixed with araldite on surface of each sand stone stab.

(d) Curing
Same as specified under para 17.1.1 (g). Further till the water proofing work on vertical face is in progress, the water proofing work done on floor slab shall be kept wet for a minimum period of 14 days. Immediately after completion of water proofing on vertical faces of side walls, the water tank shall be gradually filled with water for testing.
(e) Measurement and Rates
Same as specified under para 17.1.1(h and e) are applicable.

17.3 WATER PROOFING TREATMENT TO VERTICAL AND HORIZONTAL SURFACE OF DEPRESSED PORTION OF WC, KITCHEN AND THE LIKE

17.3.1 Preparation before the Water Proofing Treatment
17.3.1.1 Plaster and concealed work:-
Before the water proofing treatment, the internal plaster of ceiling and walls of WC block leaving the portion for dado/skirting should be completed. Grooving / chasing for doing the concealed work of GI/CI pipes/Electrical conduits should be completed. Cleaning the depressed/sunken portion of WC of all debris, extra mortar sticking to the vertical and horizontal surface etc. Necessary holes for 'P' trap /Nahani trap/Water escape pipe etc should be completed.

17.3.1.2 Preparing Surface and Fixing Pipes and Fittings
Before the water proofing treatment work, proper key in the concrete surface should be provided. The depressed/sunken portion should be hacked by a hacking tool, after the concrete slab is cast and when this concrete is still green. The vertical surfaces of the depressed /sunken portion should be hacked with a hacking tool just after the shuttering is removed. In case of old work, the water proofing treatment on such surfaces shall be permitted after making proper spatter dash key. Fixing the 'P' trap in position and all other pipes work including the water escape pipe shall be fixed properly and the holes should be plugged carefully before taking up the water proofing work.

17.3.1.3 Courses
(a) 1st course:- Cement duly blended with water proofing compound as explained in para 17.1.1 shall be used for preparing the cement slurry. The consistency of the slurry should be such that 4.4 kg. of blended cement with water proofing compound is used per sq. meter area of surface to be treated. The slurry should be started from the vertical faces towards the bottom of the floor as given Fig.4 and care should be taken to see that the slurry is applied to corners without leaving any gap.

(b) 2nd Course: - Immediately on applying the blended cement slurry on the surface to be treated cement plaster 20 mm thick in CM 1:3 (1 blended cement: 3 coarse sand) shall be applied both on vertical and horizontal surfaces taking particular care to complete the entire depressed/ sunken portion of WC within a day so that the plaster can be done without any Joint. Junctions shall be properly rounded. The surfaces of the plaster shall be left rough but finished in one plain and cured for a week. On completion of the curing period both horizontal and vertical the surfaces shall be cleaned properly, gently and allowed to dry.

(c) 3rd Course:- Only after the surface is completely dried the blown or residual bitumen shall be applied @ 1.7 kg. Of bitumen per sqm area.

(d) 4th Course: - PVC sheet 400 micron thick shall be spread evenly immediately, so that the PVC sheet sticks to the surface firmly. PVC sheet shall be continued to be laid over the main slab upto 100 mm. Overlapping of PVC sheet should be done with a minimum overlap of 100 mm, duly pasting...
overlapped sheet with an application of bitumen @ 1.7 kg./of bitumen per sqm area. The projections of pipes and 'P' trap outlet etc. inside the depressed or sunken portion of WC shall also be cladded with water proofing treatment layer upto a height of 150 mm, using a coat of bitumen with PVC sheet complete. The surfaces of depressed/sunken portion of WC shall not be left without covering with specified filling material and base concrete, otherwise the PVC sheet layer may be tampered by the labour working in the vicinity. Fixing up of WC pan, filling-specified material and the top base concrete should be done as early as possible and the top horizontal layer of water proofing may be taken up later i.e. just before laying the floor tiles.

17.3.1.4 Measurement
Length and breadth shall be measured along the finished surface correct to a cm. and area shall be worked out to nearest 0.01 sqm. No payment however shall be made for the 100 mm overlap of PVC Sheet over the roof slab.

17.3.1.5 Rate
The rate shall include the cost of labour and materials involved in all the operations described above.

17.4 PROVIDING WATER STOPS
17.4.1 Water stops conforming to IS 12200 for construction or expansion joints

17.4.2 Type of Joints for which Water Bars are provided
(a) Complete Contraction Joint: This is a movement joint with deliberate discontinuity both in concrete as well as the reinforcement but no initial gap is maintained between the concrete on either side of the Joint. This joint is intended to accommodate the contraction of the concrete.

(b) Partial Contraction Joint: This is a movement Joint with deliberate discontinuity in concrete but no water bar is provided and continuity is provided in steel. No initial gap is maintained between the concrete on either side of joint.

(c) Expansion Joint: This is a movement joint with complete discontinuity in both reinforcement and concrete. It is provided to accommodate either expansion or contraction of the structure. In general such joint requires the provision of an initial gap between the adjoining parts of the structure which accommodates expansion or contraction of the structure.

17.4.3 Types and Performance of Water Bars
Water bars are performed strips of impermeable material which are embedded in the concrete during construction so as to span across the joints and provide a permanent water tight seal during the whole range of joint movement.

The most usual form of water bars are strip with a longitudinal corrugation as shown in Fig.5. Another form of water bar of metallic type is Z shaped strip.

(Fig. 5)

Fig. 5: Typical Cross-Section of PVC Water-Stop

17.4.3.1 Material for water bar
Water bars of copper, sheet lead, natural or synthetic rubber and plastic such as polyvinyl chloride (PVC) are also used. These bars comprise of central longitudinal hollow tube with thin walls and stiff wings of about 150 mm width. Out of the metals available copper is most suitable as regards ductility, resistance to corrosion in air, water and concrete. However, it may be attacked by some wastes. If
Where the liquid stored or the atmosphere around the liquid retaining structure is not excessively corrosive i.e. sewage. Then with the specific permission of the Engineer-in-charge Galvanized iron sheets may also be used he strip water bars described as above, while placing in position has to be passed through the end shutter of the first placed concrete with the result the shuttering at this point should be perfectly water tight otherwise cement slurry may escape from the concrete being laid and will ultimately weaken the structure. Therefore to avoid the above problem one can prefer moulded type of water bar. The design of the moulded water bar with several projections needs to be passed through the end shutter while placing the same in position. Another main advantage of this water bar is that since it occupies bigger proportion of the thickness of the joint it would lengthen the shortest alternative water path through the concrete.

17.4.4 It is necessary to ensure proper compaction of concrete around the water bar. Sufficient cover to all the reinforcement shall be maintained. Sometimes to increase the bond the holes are provided in the copper water bars but in the long run it proves to be disadvantageous as it shortens the path of water through concrete. Water bars should be placed at the centre of the wall or if it is to be provided away from the centre its distance from either face of the wall shall not be less than half of the width of water bar or as specified/directed by the Engineer-in-charge.

17.4.5 Covers Plates for Joint
Sometimes joint cover plates have to be used for expansion joints mainly to avoid the risk of a fault in the water bar which is embedded. Either copper or sheet lead plate shall be used.

(a) In case the copper plates are to be used, it should be clamped to the concrete face on each side of the Joint to ensure water tightness suitable gasket shall be used.

(b) When sheet lead are to be used and fixed on the joints, Then case the edges may return into grooves formed in the concrete and can be made completely water tight by lead caulking. Faces of the concrete to which sheet lead is to be fixed should be painted with bituminous or other suitable composition and the lead sheet should be similarly coated before fixing.

17.4.6 Spacing of Joints
In Reinforced Concrete floors movement joints should be spaced at upto 7.5 m apart in two directions at right angles. The wall and floor joints should occur at the base of the wall in which case corresponding vertical joint is not important. In concrete walls, the vertical movement joints should normally be placed at spacing not more then of 0.75 m in reinforced walls. The maximum length desirable between vertical movement joints will depend upon the tensile strength of the walls and may be increased by suitable reinforcements. Amongst the movement joints in floors and walls as mentioned above, expansion joint should be normally be provided at spacing upto 30 m between successive expansion joints or between the end of the structure and the next expansion joint, all other joints being of the contraction type.

In case of expansion joints the filling of these with bitumen filler, bitumen felt or any such material etc. shall be paid for separately in running meter. The measurement shall be taken upto two places of decimal stating the depth and width of joint. In case Joint cover plates either of copper or sheet lead with ancillaries are provided, these shall be measured and paid for separately.

17.4.7 Measurement
Length shall be measured correct to a cm and net quantities shall be calculated upto two places of decimal. Each category of water stops/bar such as PVC, copper specifying width, thickness shall be measured and paid for separately.

17.4.8 Rate
The rate shall include all labour and materials in all the operations described above.

17.5 WATER PROOFING TREATMENT IN SUNKEN PORTION OF WCs, BATHROOMS ETC.
17.5.1 Preliminaries to be attended
Same as specified under Para 17.3.1.1 are applicable.
17.5.2 Preparing Surface, Fixing Pipes and Fittings
In this case, unlike as described in para 17.3.1.2, no hacking of surface need to be made, but only extra mortar sticking to the surface should be removed and the surface should be cleaned thoroughly. Fixing ‘P’ trap etc. shall be done as described in para 17.3.1.2.

17.5.3 Providing and Laying of Slurry for First Layer
The consistency of the slurry should be such as to cover the required area by using 488 gram of blended cement per sqm of area. On deciding the correct quantity of water required per sqm of area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg of grey cement + 0.253 kg. Water proofing compound as per manufacturer specifications + required quantity of water per sqm area and the required quantity of slurry thus prepared should only be used for first application.

With painting brush the first layer shall be applied over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

17.5.4 Providing and Laying of Slurry for Second Layer
The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. Cement + 0.126 kg. Water proofing compound + required liters of water per sqm area and the required quantity of slurry thus prepared should only be used for second application. The application of 2nd layer of slurry is similar as for first layer as detailed in above para. The applied surface shall be allowed to air cure for 4 hours and thereafter curing with water shall be done for full 48 hours. In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer for which separate payment shall be made to the contractor.

17.5.5 Measurement
Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

17.5.6 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above. The cost of plastering shall be measured and paid for separately.

17.6 WATER PROOFING TREATMENT FOR ROOF SLABS
17.6.1 Before starting the work of the proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fiber cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

17.6.2 Preparing Surface
Hacking of the surface but the surface is not required to be treated shall be cleaned including removing the mortar dropping from the surface.

17.6.3 Providing and Laying of Cement Slurry
The procedure to prepare and apply the cement slurry shall be same as detailed in para 17.5.3 except that over projected pipes etc. slurry shall be applied just upto 100 mm height instead of 150 mm height. The slurry shall be applied upto a height of 300 mm on parapet walls and in the groove where the fiber glass cloth is to be tucked.

17.6.4 Providing and Laying of Fiber Glass Cloth (2nd Layer)
The fiber glass cloth shall be of approved brand and manufacture. The fiber glass cloth shall be thin, flexible uniformly bonded mat composed of chemically resistant borosilicate glass fiber distributed in random open porous structure bonded together with a thermosetting resin. Immediately on applying the slurry on a sufficiently workable area as detailed above in para 17.6.3 when the slurry applied is still green the fiber glass as specified shall be spread evenly on the surface without any kink and pressed in such a way that no air spaces exist. The fiber glass cloth shall be taken upto a height of 30 cm on parapet walls and tucked in the groove specially prepared at that height. A minimum overlap of 10 cm
width shall be provided when the fiber cloth has to be joined. The joining of 100 mm overlap shall be
done with the same slurry used for the application on surface as first layer. The fiber cloth shall also be
extended upto a height of 100 mm over pipes projecting from the surface.

17.6.5 Providing and Laying of Cement Slurry for Third Layer
The quantity of water required to prepare slurry which can cover one sqm surface area to be treated
shall be calculated as given in para 17.5.3 and consider this quantity as say x liters/sqm. On deciding
the correct quantity of water required, the slurry shall be prepared by mixing 1.289 kg/m² of grey
cement + 0.67 kg. /sqm of Water Proofing Compound +1.289 kg. /sqm of coarse sand + x liters of
water. Slurry shall be prepared for the area to be covered within ½ An hour of mixing. The consistency
of the slurry shall be such that in one application with a brush 1.5 mm thickness of slurry can be coated
on the fiber glass cloth surface. This slurry shall be applied evenly on the entire surface covered with
fiber glass cloth so that a layer of 1.50 mm thickness of slurry is formed. The application of slurry shall
be continued over the 30 cm portion of parapet wall and also the portion tucked in the groove on top.
The compile surface shall be allowed for air curing for 4 hours and later the surface shall be water
cured for 7 days. On completion of curing the grooves where the fiber glass cloth is tucked shall be
closed neatly with cement mortar mixed with water proofing compound and the repaired surface should
be cured by clean water for 7 days. Fourth and final layer of brick tiling if required shall be laid and paid
for separately.

(Fig 6)

![Fig: 6: Integral Cement based waterproofing Treatment with Brick-bat Coba
Over a RCC Slab](image)

17.6.6 Measurement
Length and breadth shall be measured along the finished surface correct to a cm and area shall be
worked out to nearest 0.01 sqm Overlaps and tucking in a flashing grooves shall not be measured. Any
deductions shall not be made for openings or recess or chimney stack, roof lights or Khurras of area
upto 0.40 sqm, nor shall anything extra be paid for forming such openings, recess etc. For area
exceeding 0.40 sqm Deduction will be made in the measurement for the full opening and no extra
payment shall be done for making such opening.

17.6.7 Rate
The rate shall include the cost of labour and material involved in all the operations described above;
however the cost of brick layer with cement mortar shall be paid for separately.

17.7 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT WITH BRICK BAT COBA (Fig.
17.6)
17.7.1 Before taking up the water proofing work the action for the work describe in para 17.6.1 shall be
taken.

17.7.2 Preparing the Surface
The surface of the slab should be roughened by scrapping when the slab concrete is still green,
however, the surface need not be hacked. In case the slab is already cast and surface fairly finished,
the same shall be cleaned neatly of all mortar droppings, loose materials etc.
17.7.3 Providing and Laying of Slurry under Base Coat
The quantity of water required to prepare the slurry with 2.75 kg of blended cement to be painted over an area of 1 sqm. Shall be calculated exactly as described in para 17.5.3. Depending upon the surface area that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. Blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within 30min of preparation i.e. before the initial setting time of cement. The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc. The application of the slurry should continue upto a height of 300 mm on the parapet wall and also, the groove as shown in Fig 17.6. The slurry should also be applied upto a height of 15 cm over pipe projections etc.

17.7.4 Laying Base Coat 20 mm thick
Just after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be evenly applied over the concrete surface taking special care to check that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

17.7.5 Laying Brick Bat Coba
In coba of brick bat the brick bat of size 2.5 cm to 11.5 cm out of well burnt bricks shall be used and shall be properly dampened for six hours before laying. Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15 to 25 mm gap between two bats. Cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be poured over the brick bats and joints filled properly. Under no circumstances dry brick bats should be laid over the base coat. The haunches/goal at the junction of parapet wall and the roof shall be formed only with brick bat coba as shown in Fig.6. In case the brick bat coba is laid on the base coat. Immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba. However, if the brick bat coba is to be laid on the subsequent day, cement slurry prepared as described in para 17.7.3 shall be applied over the top surface of the base coat, and then only the brick bat coba shall be laid.

17.7.6 Application of Slurry over Brick Bat Coba
After two days of curing of brick bat coba cement slurry prepared as per para 17.7.3 shall be applied on the surface of brick bat coba. The application of slurry shall be the same as described in para 17.5.3 which should cover the haunches/goal, and the remaining small portion of parapet wall and also inside the groove as shown in the figure.

17.7.7 Laying Finishing Layer (Protective Coat)
Just after on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green, the fiber glass cloth as specified in para 17.6.4 shall be spread evenly on the surface without any kink & pressed to see that no air spaces exist. The fiber glass cloth shall be taken up to a height of 30 cm on parapet walls & tucked in the groove specially prepared at that height. 20 mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended cement: 4 coarse sand) over the entire fiber glass cloth including the haunches/goal and the small portion on the parapet wall. The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove. The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry prepared as per para 17.7.3. The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the comlite surface area.

17.7.8 Curing and Testing the Treatment
The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.

17.7.9 Measurement
The measurement shall be taken along the finished surface of treatment including the rounded and tapered portion at junction of parapet wall. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. Deduction in measurement shall not be made for openings or recesses or chimney stacks, roof lights or neither khurrras of neither area upto 0.40 sqm nor anything extra shall be paid for making such openings, recesses etc. For areas exceeding 0.40 sqm deduction will be made in the measurements for the full openings and nothing extra shall be paid for making such openings.
17.7.10 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above.

17.8 WATER PROOFING TREATMENT WITH BITUMEN FELT
17.8.0 Water proofing treatment with self finished felt shall be four or six courses as specification in the item.
(a) Four course water proofing treatment with self finished felt is a normal duty treatment suitable for buildings where the cost of roof treatment is required to be restricted.
(b) Six course water proofing treatment with self finished felt is a heavy duty treatment suitable for important structures.

17.8.1 Materials
(a) Self finished felt as given in para 17.8.1.1and 17.8.1.2 shall conform to the type and grade given in the description of the item. This shall be one of the following types:
(i) Type 3 grade 1 hessian base felt conforming in all respects to IS 1322.
(ii) Type 2 grade 1 fiber base bitumen felt conforming to IS 1322.
(iii) Type 2 grade 2 glass fiber base felt conforming in all respects to IS 7193.

17.8.1.1 BITUMEN FELTS (FIBRE HESSION BASE)
1 Weights
The weights of the ingredients used in the manufacture of bitumen felts per 10 sqm shall be not less than those specified in Table below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type of felt</th>
<th>Untreated Base Kg</th>
<th>Saturate Kg</th>
<th>Coant Kg</th>
<th>Bitumen content Kg</th>
<th>Total weight of the finished bitumen felt in dry condition with mica dusting powder Min. Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Base</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Type 2 grade 1 Hessian Base</td>
<td>0.5</td>
<td>4.5</td>
<td>12.9</td>
<td>12</td>
<td>22.6</td>
</tr>
<tr>
<td>(ii)</td>
<td>Type 3 Grade 1</td>
<td>2.3</td>
<td>1.8</td>
<td>17.7</td>
<td>12.1</td>
<td>23.0</td>
</tr>
<tr>
<td>(iii)</td>
<td>Type 3 Grade 2</td>
<td>2.3</td>
<td>1.8</td>
<td>31.8</td>
<td>20.2</td>
<td>37.1</td>
</tr>
</tbody>
</table>

Notes:
1. The weight of the untreated base shall be taken as in the dry condition.
2. Includes allowance for 1.2 kg minimum mica dusting powder in dry condition.

2 Testing
2.1 Test Frequency of test shall be fixed by the Engineer-in-charge depending on size of work. From each of the rolls one piece 3 m long and the full width of the felt shall be cut out for preparing test specimens. The first 2M. of the roll shall not be selected for this purpose. The lengths of felt so selected shall be free from abnormal defects and shall be truly representative of the whole consignment. The selected pieces of felt shall be dispatched without breakage or distortion, wrapped up in water proof paper or other similar materials so as to cause no damage to the material during transit. In case the material has stuck together, no heat shall be applied to separate the layer but the whole roll shall be sent for testing and the fact shall be reported.

The samples, when tested as per IS 1322 shall conform to the requirements given in Table A-II.
### TABLE 2

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Type of Felt</th>
<th>Breaking Strength kg</th>
<th>Pliability Test</th>
<th>Storage sticking tests</th>
<th>Heat Resistance Test</th>
<th>Pressure head test</th>
<th>Water absorption Test Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Type 2 (all grades)</td>
<td>95/60</td>
<td>(i) The roll shall not show cracks on unrolling</td>
<td>The test pieces shall be examined after cooling</td>
<td>The test pieces shall show no sign of melting of the bitumen compound</td>
<td>-</td>
<td>5.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Consider any surface rupture exceeding 5 mm in length as failure</td>
<td>After release of the load, the layers of felt shall be capable of being separated without damaging the coatant in any way</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Type 3 (all grades)</td>
<td>135/90</td>
<td>(i) The roll shall not show cracks on unrolling</td>
<td>The test pieces shall be examined after cooling</td>
<td>The test pieces shall show no sign of melting of the bitumen compound</td>
<td>-</td>
<td>2.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Consider any surface rupture exceeding 5 mm in length as failure</td>
<td>After release of the load, the layer of felt shall be capable of being separated without damaging the coatant in any way</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

#### 17.8.1.2 GLASS FIBER BASE BITUMEN FELT

**Weight:**
The weight of the ingredients used in the manufacture of glass fiber felts for 10 square meter shall be not less than those specified in Table 3.

### TABLE 3 Minimum Weight of Bitumen Glass Fiber Base Felt
For 10 Square Meter

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Type of Felt</th>
<th>Untreated Base</th>
<th>Treated Base</th>
<th>Coatant</th>
<th>Total weight in dry condition including surfacing materials (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(kg)</td>
<td>(kg)</td>
<td>(kg)</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Type 2 Gr. I</td>
<td>-</td>
<td>0.4</td>
<td>15.3</td>
<td>18.0</td>
</tr>
</tbody>
</table>
2 Tests
The sample, when tested as per IS 7193 shall conform to the requirements given in Table 4

<table>
<thead>
<tr>
<th>TABLE -4</th>
<th>Requirements of Glass Fiber Felts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sl. No.</td>
<td>Properties</td>
</tr>
<tr>
<td>(i)</td>
<td>Breaking strength, Min kg</td>
</tr>
<tr>
<td>(ii)</td>
<td>Pliability test</td>
</tr>
<tr>
<td>(iii)</td>
<td>Storage sticking</td>
</tr>
<tr>
<td>(iv)</td>
<td>Pressure head</td>
</tr>
<tr>
<td>(V)</td>
<td>Heat resistance</td>
</tr>
<tr>
<td>(vi)</td>
<td>Water absorption</td>
</tr>
</tbody>
</table>

(b) Bonding Materials: This shall either consist of blown type petroleum bitumen conforming to IS 702 or residual petroleum bitumen conforming to IS 73. The bonding material shall be so selected as to withstand the local condition of temperature and gradient satisfactorily. The penetration of bitumen used shall not exceed 40 in any case. Suitable residual type petroleum bitumen of penetration 30/40 (IS grade S-35), residual type petroleum bitumen with higher penetration and low softening point and suitable blown type petroleum bitumen of IS grade 85/25 or 90/15 of approved quality shall be used. Where proprietary brands of bonding materials are proposed to be used they shall conform in all respects to the specifications in the preceding para.

<table>
<thead>
<tr>
<th></th>
<th>1st course kg/sqm</th>
<th>3rd course kg/sqm</th>
<th>5th course kg/sqm</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>1.45</td>
<td>1.45</td>
<td>—</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Six course treatment: (a) With type 3 grade 1 hessian base self finished bitumen felt.</td>
<td>1.45</td>
<td>1.20</td>
</tr>
<tr>
<td>(b)</td>
<td>With felts other than type 3 grade 1 hessian base.</td>
<td>1.45</td>
<td>1.20</td>
</tr>
</tbody>
</table>

(c) Stone Grit and Pea-sized Gravel: Stone grit shall be 6 mm and down size. Where pea-sized gravel is used it shall be hard, round, free from dust and dirt etc. The stone grit or pea-sized gravel shall not be spread over vertical and sloping faces of flashings and at drain mouths. At these places the surface shall be painted with two coats of bituminous solution. The quantity of stone grit or pea-sized gravel required for the final course of four or six course treatment with hessian base self finished bitumen felt type 3 grade 1 shall be 6 cubic decimeter/ sqm.

17.8.2 Preparation of Surface
(a) The surface to be treated shall have a at least a slope of 1 in 120. This grading shall be carried out with cement concrete or cement plaster with coarse sand, as desired to the average thickness required and finished smooth. Separate payment shall be made for such grading.

(b) Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be cased by running triangular fillets 7.5 x 7.5 cm size, in cement concrete. At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. Cement concrete where used shall be 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.

(c) In existing roof where goal and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks etc., these shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing. Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface in the water proofing treatment.
(d) When the grading of roof surface is being done, it shall be ensured that the outlet drain pipe has been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water.

(e) While any pipe passes through the roof to be treated, angular fillet of shape shown in Fig.9 shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately.

(f) For carrying over and tucking in the water proofing felts into the parapet walls, chimney stacks etc. a horizontal groove 6.5 cm deep, 7.5 cm wide section with its lower edge at not less than 15 cm above the graded roof surface shall be left on the inner face of the same during construction if possible. When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand). Such cutting of the groove and its finishing smooth shall be deemed to be part of the water proofing item and shall not be measured or paid for separately. No deduction shall be made either for not making the groove or when the later has already been left in the masonry by the construction agency.

(g) If the parapet wall exceeds 45 cm in the height from the graded surface then Tucking in the water proofing felt will be required. Where the height is 45 cm or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. In the case of low dividing walls of height 30 cm or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately.

(h) Where expansion joints are left in the slab, the provision of dwarf walls or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included the operation of water proofing.

(i) The graded surface of the roof and concrete fillets and the faces of walls shall be completely cleaned with wire brushes and all loose scales etc. removed. Then The surface shall be dusted off. Any crack in the roof shall be cut to 'V' section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement: 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

17.8.3 Priming Coat
If so specified, or required by the Engineer-in-Charge for example under slightly damp conditions a priming coat consisting of a bitumen primer conforming to IS 3384 should be applied with brush on the roof and wall surface at 0.24 liters per sqm to assist adhesion of the bonding material (i.e. bitumen). Such application of primer shall be paid for separately, unless specifically included in the water proofing item.

17.8.4 Underlay
Where a floating treatment of water proofing with self finished bitumen felt is required i.e. where water proofing treatment is required to be isolated from the roof structure, a layer of bitumen saturated felt (underlay) shall be spread over the roof surface and tuck into the flashing groove. No bonding material shall be used below the underlay in order to keep the underlay free of the structure. The adjoining strips of the underlay shall overlap to a minimum of 7.5 cm at sides and 10 cm at ends. The overlaps shall be sealed with the same bonding material as used for the self finished felt treatment. Unless specifically included in the water proofing item, the underlay treatment shall be paid for separately. The underlay shall be of type 1 saturated felt conforming to IS 1322 in all respects and having a total minimum weight of the finished bitumen felt in dry condition with mica dusting powder @ 6.8 kg/10 sqm. The roll shall not be damaged or crack on being unrolled on a fairly smooth and flat surface.

17.8.5 Treatment
(a) The water proofing shall consist either of a four or six course treatment, as given in the description of the item, each layer of bonding materials, self finished bitumen felt or stone grit or pea sized gravel being counted as a course.

(b) The choice of a four or six course treatment will depend on the climatic condition, the importance of the building, the durability required, cost and other relevant considerations.
(c) A four course treatment shall consist of the following layers:
(i) Initial layer of bonding material applied hot at specified weight per unit area.
(ii) 2nd layer of self finished bitumen felt conforming to the type and grade given in the description of the item.
(iii) Third layer of bonding material.
(iv) Final layer of stone grit or pea sized gravel spread at specified volume of material per unit area.

(d) In a six course treatment, the first, second and third layer shall be of the same as in the four course treatment. The fourth and fifth layer shall consist of self finished felt and bonding material respectively. The sixth layer shall consist of stone grit or pea sized gravel.

(e) The primer or underlay where required to be provided shall not count against the number of courses specified.

17.8.6 Laying
(a) Bitumen bonding material of required grade shall be heated to the working temperature specified for the particular grade by the bitumen manufacturers and conveyed to the roof in buckets or pouring cans in weighed quantities. Suitable working temperature for different grades of bitumen is as under:
(i) Blown type petroleum bitumen of IS grade 85/25 or 90/15 – 180°C.
(ii) Residual type petroleum bitumen of penetration 30/40 -180° to 190° C (IS grade S-35).

(b) Drain outlets shall be given a four or six course treatment as given for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

(c) Required length shall be cut from the self finished felt. If shall be brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The felt shall normally be laid in length at right angles to the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. The felt shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m is suitable lengths. The roof surface shall be cleaned and dried before the felt treatment is begun. Each length of felt shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be leveled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unraveled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner. Each strip shall overlap the proceeding one by at least 7.5 cm at the longitudinal edges and 10 cm at the ends. All overlaps shall be firmly bonded with hot bitumen. Streaks and tailings of bitumen near edges of laps shall be leveled by heating the overlap with a blow lamp and leveling down unevenness. The third layer of bonding material in the four course treatment shall be carried out in a similar manner after the flashing has been completed.

(d) In a six course treatment the third and fourth layers of bonding material and self finished felt shall be laid in the manner already described, taking care that laps in the felt are staggered from those in the second layer. The fifth layer of bonding material shall be carried out after the flashing is done (See Fig. 7).

(e) High Parapet Walls, Chimney Stacks etc.: Wherever junctions of vertical and horizontal surfaces occur Felts shall be laid as flashings. The longitudinal laps shall be 10 cm. The lower layer of flashing felt in a six course treatment shall overlap the roof water proofing by not less than 20 cm while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing felt in four course specification over the roofing felt shall be 10 cm. The flashing shall consist of the same four or six course treatment as for the roof except that the final course of stone grit or pea-sized gravel shall be replaced by an application of bituminous solution of approved quality in two coats on the vertical and sloping faces only, of the flashing. The overlap along the length of flashing shall stagger with those in the second layer of flashing felt (in a six course treatment and with the joints in the roof felt). The upper edge of the flashing felt shall be well tucked into the flashing grooves in the parapet; chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals
and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 7). After the top flashing felt layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing felt and the horizontal overlaps and vertical and sloping surfaces of the flashings at the specified rate. Stone grit or pea sized gravel shall then be spread uniformly over the hot bonding material on the horizontal roof surface at the specified quantity per unit area and pressed into it with a wooden roller.

(f) **Low Parapet Walls:** If parapet walls are of height up to 45 cm, bitumen felt flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried up to the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm (see Fig. 7).

(g) **Low Dividing Walls:** Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 7). Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

(h) **Expansion Joints:** Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with waterproofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precast RCC cover slabs as given in Fig. 7. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throating on their underside along their length. The waterproofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs. The formation of the expansion Joints and provision of cover slabs shall be the responsibility of the construction agency. The formation of the Junction fillets and the waterproofing treatment of the joints and cover slabs shall be carried out by the waterproofing agency. No extra shall be paid for the junction fillers or for the sealing of the cross joints in the cover slab with 15 cm width of bitumen strips.

(Fig no 7)

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**Fig: 7 Water Proofing**
(l) **Pipes**: Where vertical pipe outlets are met with 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid. The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

(j) **Terrace**: Where roof surfaces are expected to be used precast cement concrete tiles or 40 mm thick cement concrete shall be laid on the waterproofing treatment. In such cases, the final course of stone grit or pea sized gravel shall not be laid in the waterproofing treatment. Suitable adjustment in the rates will be effected for not providing the stone grit or pea sized gravel layer. Cement concrete in situ flooring shall be laid in panel not exceeding 0.4 square meters each. Precast tiles or in situ concrete flooring where laid shall be paid for separately unless included in the description of the waterproofing item.

17.8.7 **Measurements**

(a) Length and breadth shall be measured correct to a cm. The area shall be calculated in square meters correct to two places of decimal.

(b) Measurements shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints and at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured.

(c) Vertical and sloping surfaces of waterproofing treatment shall also be measured under the four or six course treatment as the case may be, irrespective of the fact that the final course of grit or pea sized gravel is replaced by bitumen primer.

(d) Primer or saturated felt underlay, where provided, shall also be measured in the same manner as the waterproofing treatment and paid for separately. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and neither the like, for areas upto 40 square decimeter (0.4 sqm) nor anything shall be paid for forming such openings. For similar areas exceeding 40 sq. decimeter deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

17.8.8 **Rate**
The rate shall include the cost of all labour and materials involved in all the operations described above and the particular specifications given under the different items, with the corrections noted in the relevant sub para.

17.9 **GRADING ROOF WITH CEMENT CONCRETE 1:2:4**

17.9.1 **Materials**
Cement, coarse sand and graded stone aggregate 20 mm nominal size, shall be used as specified in the item. The specifications for the materials and method of preparation of concrete shall conform in general to the specification described in sub-head 3.0 of Specifications.

17.9.2. **Laying**: Before laying cement concrete for grading, the level markings to the desired slope/gradient shall be made only with cement concrete on the surface of the slab at suitable spacing with the help of string and steel measuring tape so that the mason can lay the concrete to the required thickness, slope / gradient easily in between the two level markings. On getting the level marking approved by the Engineer in charge the surface should be sprinkled with thick cement slurry and the concrete should be laid carefully, without throwing from height, in predecided strips. The concrete should be consolidated by specially made wooden tamping. After the tamping is done the surface should be finished to required slope/gradient with wooden trowels without leaving any spots of loose aggregates etc. The mixed cement concrete must be laid in position, within half an hour of its mixing. If any quantity of concrete remains unused for more than half an hour the same should not be used.

17.9.3 **Finishing and thickness**: The slope of finished terrace shall not be more than 1 in 120 unless a steeper slope is required by the Engineer-in-Charge. The minimum thickness of the concrete at its junction with Khuras or parapets shall be 5 cm. The concrete shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/goal/filler at the junction of the parapet wall and the roof slab as shown in Fig. The finished concrete surface shall present a smooth surface with correct
slopes and uniform rounding. The concrete should be free from cracks and the excess trowelling shall be avoided.

(FIG: 8)

![FIG 8: Grading Roof Slab with Cement Concrete](image)

17.9.4 Curing: Curing shall be done either by spreading straw/Hessian cloth over the graded surface, keeping the same wet for full 10 days or flooding the graded area with water by making kiaries with weak cement mortar, for 10 days. Occasional curing by simply spraying water now and then shall not be permitted under any circumstances.

17.9.5 Measurement: Length and breadth shall be measured correct to a cm. Area shall be worked out to nearest 0.01 sqm. and the cubical contents shall be worked out to nearest 0.001 cum. No deduction shall be made for either opening or recesses for chimney stacks, roof lights etc., Khurras for area upto 0.1 sqm. Nothing extra shall be paid either for any extra material or labour involved in forming such opening or recess or in rounding the concrete function of roof with parapet walls, chimney stack, Khurras etc.

17.9.6 Rate: The rate shall include the cost of all the materials and labour involved in all the operations described above.

17.10 GRADING ROOF WITH CEMENT MORTAR

17.10.1 Materials
Cement and coarse sand shall be as specified in the item of work and cement mortar 1:3 (1 cement: 3 coarse sand) /1:4(1 cement: 4 coarse sand) specified in the item of work shall conform to the specification described in sub-head 2.0 of Specifications.

17.10.2 Preparation of the Surface: The surface shall be cleaned properly with brooms or cloth to remove all dirt, dust, mortar droppings.

17.10.3 Laying: Same as described in para 17.9.2, except that cement mortar shall be tamped with wooden and steel trowels and surface finished with steel trowel.

17.10.4 Finishing
The slope of finished surface shall not be more than 1 in 120 unless a steeper slope is specified in the item of work. The finished surface of the grading shall present a smooth surface with correct slopes and uniform rounding’s wherever they are provided. The mortar surface shall be free of cracks and the excess trowelling shall be avoided.

(FIG: 9)

![FIG 9: Grading Roof slab with cement Mortar 1:3/1:4](image)
17.10.5 *Thickness*: The minimum thickness of cement mortar grading at the junction with khurras or parapet wall shall be 20 mm. The cement mortar shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/goal/filler at the junction of parapet wall and the roof slab. The maximum thickness that shall be adopted for grading with cement mortar shall be 50 mm. It is not at all desirable to lay the cement mortar grading for greater thickness and in that case it is advised to go in for grading with Cement Concrete. The average thickness shall be as shown in Fig. 9 and 10

17.10.6. *Curing, measurement and rates*: same as specified in para 17.9.4 to 17.9.6 are applicable.

![FIG. 10: Grading Chajja with Cement Mortar 1:3/1:4](image)

**17.11 WATER PROOFING TREATMENT WITH APP (ATACTIC POLYPROPYLENE POLYMERIC) MEMBRANE**

Water proofing treatment of roofs with APP modified polymeric membrane shall be either five course or seven course as specified in the item. In selecting the combinations of layers of APP membrane, consideration shall be given to the type and construction of buildings, climate and atmospheric conditions and the degree of permanence required. Five course treatment is a normal treatment suitable to moderate rainfall conditions (less than 50 cm.) and seven course treatment is suitable for heavy rainfall (50 cm and above).

**17.11.1 Materials**

The bitumen primer shall conform to the requirements laid down in IS 3384.

(a) **APP Modified Membrane**: This is a polymeric water proofing membrane manufactured to high standards. It is five layered APP modified polymeric membrane with centre core as 20 micron HMHDPE/100 micron HMHDPE High Molecular High Density Polyethylene Film, is the heart of the membrane and protects against water and moisture. The centre core is sandwiched on both sides by high quality polymeric mix with properties of high softening point, high heat resistance and cold resistively to make it ideal for all water proofing treatment. The polymeric mix is protected on both sides with 20 micron HMHDPE film. The membrane is, available in variable thickness and weights. Usual width is 1.0m. Important physical and chemical parameter of the membrane shall be as given in Table 5 for guidance.

<table>
<thead>
<tr>
<th>Centre Core</th>
<th>Film</th>
<th>Thickness</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 micron HMHPDE</td>
<td>20 micron HMHPDE</td>
<td>1.5 mm</td>
<td>2.25 kg/sqm.</td>
</tr>
<tr>
<td>100 micron HMHPDE</td>
<td>20 micron HMHPDE</td>
<td>2.00 mm</td>
<td>3.00 kg/sqm.</td>
</tr>
</tbody>
</table>

Where proprietary brands Ataxic Polypropylene modified polymeric membrane is proposed to be used by the contractor, they shall conform in all respect to the specification in the preceding para and manufactured by a company of repute.

(b) **Bonding Material**: If shall consist either of blown type bitumen conforming to IS 702 or residual bitumen 85/25 conforming to IS 73 heated to the correct working temperature of 180°C. The penetration of the bitumen shall not be more than 40 when tested in accordance with IS 1203, unless
otherwise specified each coat of bonding material shall be of blown type bitumen of grade 85/25 heated to a working temperature of 180 °C and applied @ 1.20 kg/sqm of the surface area.

17.11.2 Surface Finish: Surface finish shall be with brick tiles of class designation 100 grouted with cement mortar 1:3 (1 cement : 3 fine sand) with 2% integral waterproofing compound by weight of cement over a 12 mm thick layer of cement mortar 1:3 (1 cement: 3 fine sand) and finished neat, as shown in Fig. 11. Surface finish shall be measured and paid for separately.

17.11.3 Preparation of Surface: shall be as specified in para 17.8.2 is applicable.

17.11.4 Treatment: The water treatment shall be of five or seven course as specified.

In seven course treatment, the first four courses shall be the same as for five course treatment. The fifth course shall be a layer of APP modified polymeric membrane. The sixth course shall be a coat of bonding material and the top most seventh course shall be of specified surface finish.

17.11.5 Laying
(a) First course shall be a coat of bitumen primer @ 0.40 kg/sqm followed by subsequent course as per treatment required.

(b) Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

(c) Required length of The APP modified polymeric membrane shall be cut, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The membrane shall normally be laid in lengthen the direction of the slope and laying shall be commenced at the lowest level and worked up to length. The membrane shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m is suitable lengths. The roof surface shall be cleaned and dry before starting the membrane treatment. Each length of membrane shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled membrane as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be leveled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner. Each strip shall overlap the preceding one by at least 7.5 cm. at the longitudinal edges and 10 cm. at the ends. All overlaps shall be firmly bonded with a blow lamp and leveling down unevenness. The fourth layer of bonding material in the five course treatment shall be carried out in a similar manner after the flashing has been completed.

(Fig: 11)

Fig. 11 : Five Course Water Proofing Treatment with APP Modified Polymeric Membrane

(d) In a seven course treatment the fifth layers of membrane shall be laid in the manner already described, taking care that laps in the membrane are staggered from those in the earlier layer. The sixth layer of bonding material shall be carried out after the flashing is done.

(e) High Parapet Walls, Chimney Stacks etc.: Membrane shall be laid as flashing wherever Junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing
membrane in a six course treatment shall overlap the roof water proofing by not less than 20 cm. while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing membrane in five course treatment over the roofing membrane shall be 10 cm. The flashing shall consist of the same five or seven course treatment as for the roof except that the final course shall be replaced by an application of 12 mm thick cement plaster 1:3 on the vertical and sloping faces only, of the flashing as shown in Fig 10. The overlap along the length of flashing shall stagger with those in the second layer of flashing membrane (in a seven course treatment and with the joints in the roof membrane).

The upper edge of the flashing membrane shall be well tucked into the flashing grooves in the parapet; chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 11). After the top flashing membrane layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing membrane and the horizontal overlaps and vertical and sloping surfaces of the flashing at the specified rate.

(f) **Low Parapet Walls:** Where parapet walls are of height 45 cm. or less, membrane flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried up to the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.

(g) **Low Dividing Walls:** Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carries down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 7).

Drain outlets where formed in the low dividing walls, shall be given waterproofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

(h) **Expansion Joints:** Where the expansion Joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and dwarf walls by not less than 7.5 cm. and are provided with throating on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roofs slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs. The formation of the expansion joints and provision of the cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. Nothing extra shall be paid for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

(i) **Pipes:** Where vertical pipe outlets are met with, 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shown in Fig.7 shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid. The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

**17.11.6 Measurement:**

Length and breadth shall be measured correct to a cm. The area shall be calculated in square meters correct to two places of decimal. Measurements shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion Joints and at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured.
Vertical and sloping surfaces of waterproofing treatment shall also be measured under the five or seven course treatment as the case may be, irrespective of the fact that the final course is replaced by bitumen primer. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and neither the like, for areas up to 0.4 sqm nor anything shall be paid for forming such openings. For areas exceeding 0.40 sqm deduction will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

17.11.7 Rate: The rate shall include the cost of all labour and materials involved in all the operations described above. The top most layer shall be paid for separately.

17.12 FIVE LAYERED WATER PROOFING TREATMENT WITH ATACTIC POLYPROPYLENE POLYMER MODIFIED PREFABRICATED MEMBRANE

Atactic polypropylene Polymer modified prefabricated five layer water proofing membrane shall be of thickness as specified. In selecting thickness of membrane due consideration shall be given to the type and construction of building, climate and atmospheric condition and permanence required. Five layered treatment 2 mm thick with glass fiber is with a normal duty treatment suitable for pitched roofs. Five layered 3mm thick with glass fiber matt treatment is suitable for moderate condition of rainfall (50 to 150 mm) and five layered 3mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

17.12.1 Materials

Bitumen primer for bitumen membrane shall have density at 25°C in the range of 0.87 - 0.89 kg./liter and viscosity of 70-160 CPS primer shall be applied @ of 0.40 liter/sqm.

(a) Atactic Polypropylene Polymer Modified Prefabricated Membrane: It is a polymeric waterproofing membrane and shall be one of the following types:-
(i) 2 mm thick with glass fiber matt.
(ii) 3 mm thick glass fiber matt.
(iii) 3 mm thick with non-woven polyester matt.

It is prefabricated five layered black finish water proofing membrane comprising of centre core of 50 gms. Glass fiber matt/170 gms no woven polyester matt sandwiched on both sides by APP polymer modified bitumen which is protected on both sides by 20 micron thermo fusible polyethylene sheet. Composite thickness of the membrane including all five layers shall be 2/3 mm with glass fiber matt and 3 mm with non woven polyester matt. It is available in 1 m width and variable lengths.

Physical and chemical parameters of the membrane shall be as given in below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>No. of Layers</th>
<th>Thickness</th>
<th>Elongation at 23° C in longitudinal direction</th>
<th>Joint strength in longitudinal and Transverse direction</th>
<th>Tear strength in longitudinal and Transverse direction</th>
<th>Softening Point</th>
<th>Cold flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Five Layered reinforced with fiber glass</td>
<td>2 mm</td>
<td>3 N/5 cm.</td>
<td>350/300 N/5 cm.</td>
<td>60/80 N</td>
<td>150°</td>
<td>-2°C</td>
</tr>
<tr>
<td>2</td>
<td>Five Layered reinforced with fiber glass</td>
<td>3 mm</td>
<td>3.3 N/5 cm.</td>
<td>350/3000 N/5 cm.</td>
<td>60/80 N</td>
<td>150°</td>
<td>-3°C</td>
</tr>
<tr>
<td>3</td>
<td>Five Layered reinforced with non-woven polyester matt.</td>
<td>3 mm</td>
<td>40/50 N/5 cm.</td>
<td>650 N/450 N/5 cm.</td>
<td>300/250 N</td>
<td>150°</td>
<td>-2°C</td>
</tr>
</tbody>
</table>

When tested Atactic polypropylene modified black finished is proposed to be used shall conform in all respects to the specification in the preceding para. The work should be got done through authorized applicator/specification agency.

17.12.2 Preparation of Surface: The surface to be treated shall have a minimum slope of 1 in 120 or as specified, provision specified in para 17.8.2 shall apply for preparation of surface except for pitched roof where surface shall be cleaned off any loose material dust etc. To ensure good adhesion between
the surface and water proofing treatment suitable method to dry the surface shall be adopted. All hair line cracks in the surface should be filled with approved sealant.

**17.12.3 Treatment:** The water proofing shall consist of prefabricated five layered 2 mm or 3 mm membrane as shown in Fig. 12. The choice of 2 mm or 3 mm membrane will depend on the type of roof i.e. pitched or flat and importance of building, durability, cost and rainfall etc.

(Fig 12)

![Fig. 12: Five Layers Water-Proofing Treatment with APP Modified Prefabricated](image)

**17.12.4 Laying:** Bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and all other surfaces where polymer modified membrane is to be laid. The five layered water proofing membrane shall be laid using Butane torch and sealing all joints and preparing the surface complete. Drain outlets shall be given similar treatment as specified for the roof in the description of the item in the manner describe for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outsets by at least 10 cm. The APP polymer modified prefabricated water proofing membrane shall be cut to the required length. Water proofing membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. APP water proofing membrane shall be laid in 6 to 8 m lengths. The roof surface shall be cleaned and bitumen primer shall be applied in the correct quantity, over this specified water proofing membrane shall be laid with butane torch after allowing 24 hours for primer to dry. Each strip shall overlap the preceding one by at least 10 cm. at the longitudinal edges and 15 cm. at the ends. All overlaps shall be firmly bonded with bitumen primer and leveled by heating the overlap with butane torch. If the roof is accessible the treatment is protected by brick tiles laid over 12 mm thick cement mortar of specified grade bedding and joints sealed with cement mortar of which shall be measured and paid for separately. APP water proofing membrane shall be laid as flashing wherever junction of vertical and horizontal surfaces occurs. Longitudinal laps shall be 10 cm. The upper edge of flashing membrane shall be well tucked into the flashing grooves in the parapets, chimney stack etc. to a depth of not less than 6.5 cm; corresponding applications of primer coat shall also be made. The flashing treatment shall be firmly held in the grooves and it shall be sealed with the approved sealant after terminating the membrane.

When parapet walls are of height 45 cm or less APP water proofing membrane flashing shall be provided in the same manner as for flashing in the core of high parapet walls except that upper edge shall be carried out the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.

Where low dividing walls or inverted beams are met with, the same treatment shall be provided as for the main roof, the lateral bearing carried down both sides of the wall and overlapping the roof treatment. Drain outlets where formed in the low dividing walls, shall be given water proofing treatment same as for the main roof.

Where the expansion Joints are provided in the slabs, the Joints and their cover slabs shall be suitably treated with water proofing treatment. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throating on their underside along their length. The water proofing treatment shall be taken up the slopping Junction fillets and the vertical faces of the walls to the underside of the cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm. width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their
full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs. The formation of the expansion joints and provision of cover slabs shall be the responsibility of construction agency. The formation of the joint’s fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the joint’s fillets or for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

17.12.5 Measurements: Length and breadth shall be measured correct to a cm. The area shall be calculated in square meters correct to two places of decimal. Measurement shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints at pipe projections etc. overlaps and tucking into flashing grooves shall not be measured. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and neither the like, for areas upto 40 square decimeter (0.4 sqm.) nor any thing shall be paid for forming such openings. For areas exceeding 0.40 sqm. deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

17.12.6 Rate: The rates shall include the cost of all labour and materials involved in all the operations described above.

17.13 EXTRA FOR COVERING OF APP MODIFIED PREFABRICATED MEMBRANE WITH GEOTEXTILE

17.13.1 If the water proofing treatment of flat roof has been done with APP modified five layered membrane and the roof is accessible, a separation layer on top of membrane should be laid before any protected treatment is done. Brick tiles in cement mortar or 25 mm thick cement concrete 1:2:4 shall be laid as final layer as shown in Fig. 17.12. Geotextile 120 gm. Non woven 100% polyester of thickness 1.0 to 1.25 mm manufactured by a company of repute shall be used. Geotaxis of the specified thickness is bonded to the water proofing membrane with intermittent touch by heating the membrane by Butane torch as per manufacturing recommendations.

17.13.2 Measurements: Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the entire exposed area of roofing.

17.13.3 Rate: The rate shall include the cost of all labour and material involved in all the operations described above- Final layer of brick tiles or 25 mm thick cement concrete shall be measured and paid for separately.
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18.0 HORTICULTURE & LANDSCAPE
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18 HORTICULTURE WORK
The horticultural operations shall be started on the ground previously leveled and dressed to the required formation levels and slopes. In case where unsuitable soil is met with, it shall be removed, replaced or covered over to a thickness decided by the Engineer-in-charge with good earth.

18.1 TRENCHING IN ORDINARY SOIL
18.1.1 Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regressing, Hedging and shrubbery.

During horticultural operations, any walls, foundations, etc. met with in trenching or excavation shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for regressing in good soil. The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good earth. Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed off and paid.

Trenching shall consist of the following operations:
1. The whole plot area shall be divided into narrow rectangular strips of about 1.5 m width then these strips shall be sub-divided lengthwise into about 1 m long which shall be excavated serially and excavated soil deposited in the adjacent section preceding it,
2. In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.
3. The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

18.1.2 Measurements
Length and breadth of the plot shall be measure correct to 0.1 m and depths correct to cm and cubical contents shall be calculated in cum, correct to two places of decimal. No deduction shall be made nor extra paid for removing stones, brick bats and other foreign matter met with during excavation upto initial lead of 50 m and stacking the same.

18.1.3 Rate
The rate shall include the cost of all labour and material involved in the operations of trenching as described above, including cost of all precautionary measures to be taken for protections and supporting all services etc. It does not include the cost of mixing of earth, sludge or manure.

18.2 GOOD EARTH
18.2.1 At site the earth shall be stacked at site in stacks not less than 50 cm high and not less than 3.0 cum in volume.

18.2.2 Measurements:
In stacks of good earth Length, breadth and height shall be measured correct to a cm and 20% shall be reduced for wide’s in volume before payment unless otherwise described.

18.2.3 Rate: The rate shall include the cost of excavating and transporting the earth from areas lying at distance not exceeding one km. from the site, breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

18.3 OILCAKE
18.3.1 Neem/Castor:
The cake shall be free from grit and any other foreign matter and should be undecorticated and pulverized.

Before supply the quality of cake should be got approved by the Engineer-in-charge.
18.3.2 Measurements
The arrangement for weighing shall be made at site by the department. The gunny bags shall be the property of the government. The material shall be packed in old serviceable gunny bags of 50 kgs capacity approximately excluding weight of gunny bag shall be made for net quantity.

18.3.3 Rate: The rate shall include the cost of labour and material involved in all operations described above, carriage up to site of work with all lead and lifts and, weighing etc.

18.4 SUPPLY AND STACKING OF SLUDGE
18.4.1 It shall be transported to the site in lorries with efficient arrangement to prevent spilling enrooted and stacked at site. Each stack shall not be less than 50 cm height and volume not less than 3 cum.

18.4.2 Measurements
Length, breadth and depth of stacks shall be measured correct to a cm, and the volume of the stack shall be reduced by 8% for looseness in stacking and to arrive at the net quantity for payment.

18.4.3 Rate
The rate shall include the cost of labour and material involved in all operations described above, including carriage up to one km and royalty if payable.

18.5 SUPPLY AND STACKING OF MANURE
Same as above in para 18.4 to 18.4.3

18.6 ROUGH DRESSING OF THE TRENCHED GROUND
18.6.1 Rough dressing of the area shall include making kiaries for flooding. The trenched ground shall be leveled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so leveled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at the surface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

18.6.2 Measurements
Length, breadth of superficial area shall be measured correct to 0.1 meter. The area shall be calculated in sqm. Correct to two places of decimal.

18.6.3 Rate
The rate shall include the cost of all the labour and material involved in all the operations described as above.

18.7 UPROOTING WEEDS FROM TRENCHED AREAS
18.7.1 After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

18.7.2 Measurements
Superficial area length and breadth of the weeded ground shall be measured correct to 0.1 meter.

18.7.3 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above.

18.8 FINE DRESSING THE GROUND
18.8.1 Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

18.8.2 Measurements
Length, breadth and depth of stacks shall be measured correct to a cm. The area shall be calculated in sqm. correct to two places of decimal.
18.8.3 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above.

18.9 SPREADING GOOD EARTH
18.9.1 Good earth shall be removed from stacks by head load and spread evenly over the surface on entire area with a twisting motion in uniform way to avoid segregation.

18.9.2 Measurements: The quantity shall be determined by the difference in the volume of good earth in stacks before and after spreading duly reduced for looseness in stacking by 20% of good earth.

18.9.3 Rate: The rate shall include of all the labour and material involved in all the operations described above, but excluding cost of the good earth which shall be paid for separately unless specifically described in the item.

18.10 SPREADING SLUDGE OR MANURE
18.10.1 Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item and mixture shall be spread in as described in para 18.9.1 to the thickness as directed by the Engineer-in-Charge.

18.10.2 Measurements
The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth and sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

18.10.3 Rate
The rate shall include of all the labour and material involved in all the operations described as above, but excluding the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

18.11 MIXING OF GOOD EARTH AND SLUDGE/MANURE
18.11.1 The stacked earth before mixing shall be broken down top particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge.

18.11.2 Measurements
The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth, sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

18.11.3 Rate
The rate shall include the cost of all labour and materials involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

18.12 GRASSING WITH SELECT GRASS NO. 1
18.12.1 At the time of execution of work the area from where the grass roots are to be obtained shall be specified by the Engineer-in-Charge. No royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor (cost of grass to be paid separately).

18.12.2 The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material (grass shall be paid separately.)

18.12.3 Constant watch shall be maintain to ensure that During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle
straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary and dead patches are replanted and weeds are removed.

18.12.4 Measurements
Length, breadth of the lawn grassed shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

18.12.5 Rate
The rate shall include of all the labour and material involved in all the operations described above, excluding supply of the requisite quantity of good earth and grass so needed for properly maintaining the levels of the lawns, (payment of grass to be paid separately).

18.13 RENOVATION OF LAWNS
18.13.1 The area shall be first weeded out of all undesirable growth. The entire grass shall be scrapped (cheeled) without damaging roots and level of the grounds. Slight irregularities in surface shall be leveled off and the area shall then be forked so as to aerate the roots of the grass without, however uprooting them.

Specified quantity of sludge or manure shall than be spread uniformly with wooden straight edge (phatti). The area shall then be slightly sprinkled with water so as to facilitate proper integration of the manure or sludge with the soil and later flooded. The contractor shall be responsible for watering, proper maintenance and tending of the lawn for 30 days or till the grass forms an lawn fit for mowing, whichever is later. All undesirable growths shall be constantly weeded out and all rubbish removed and disposed off as directed by the Engineer-in-Charge.

18.13.2 Measurements
Length, breadth of the lawn renovated shall be measured correct to 0.1 meter and the area shall be calculated in sqm. Correct to two places of decimal.

18.13.3 Rate
The rate shall include of all the labour and T&P (excluding RH pipe/grass) involved in all the operations described above, excluding the supply of the requisite quantity of good earth if so needed for proper maintenance of the levels of the lawns. The cost of the sludge or manure shall be measured and paid for separately, unless its supply is specifically included in the description of the item.

18.14 UPROOTING RANK VEGETATION AND WEEDS AND PREPARING THE GROUND FOR PLANTING SELECT GRASS NO. 1
18.14.1 Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetarian with roots removed thereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described in 18.1. Clods of excavated earth shall then be broken upto the size not more than 75 mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully. The rubbish arising from the above operations shall be removed and disposed off in a manner directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed as described in 18.6 & 18.8.

18.14.2 Measurements
Length, breadth of uprooted area shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

18.14.3 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above.

18.15 EXCAVATION AND TRENCHING FOR PREPARATION OF BEDS FOR HEDGE AND SHRUBBERY
18.15.1 Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters respectively.

18.15.2 Beds for hedges and shrubbery shall be prepared in the following manner. The beds shall first be excavated to a depth of 60 cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in order to loosen
the soil, in the manner described in 18.1. No flooding will be done at this stage but the top surface shall be rough dressed and leveled. The excavated soil from the top 60 cm depth of the bed stacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8:1 by ratio or other proportion described in the item. The mixed earth and manure shall be refilled over the trenched bed, leveled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed. The surface after full subsidence shall again be refilled with the earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50 mm to 75 mm below the adjoining ground or as directed by the Engineer-in-Charge. Surplus earth if any, shall be disposed off as directed by the Engineer-in-charge. Any surplus earth if removed beyond initially lead shall be paid separately. Stones, bricks bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initially lead & lift, such material as is declared unserviceable by the Engineer-in-charge shall be disposed by spreading and leveling at places ordered by him. If disposed outside the initial lead & lift, then the transport for the extra leads will be paid for separately. If a large proportion of material unsuitable for the hedging and shrubbery operations is met with and earth from outsides is required to be brought in for mixing with manure and filling, the supply and stacking of such earth will be paid for separately.

18.15.3 Measurements
Length, breadth and depth of the pit excavated and trenched shall be measured correct to a cm. The cubical contents shall be calculated in cubic meter correct to two places of decimal.

18.15.4 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above. The rate shall not include the cost of supply & stacking of the manure unless the same is specifically included in the description of the item.

18.16 DIGGING HOLES FOR PLANTING TREES
18.16.1 In ordinary soil, including refilling earth after mixing with oil cake, manure and watering. Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The material shall be packed in old serviceable gunny bags of 50 kgs capacity approximately. The weight of gunny bag shall be deducted @1 kg per bag and payment shall be made for net quantity.

The tree holes shall be mannered with powdered Neem/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

18.16.1.2 Measurements: Holes shall be enumerated.

18.16.1.3 Rate; The rate shall include the cost of all the labour and material involved in all the operations described above, excluding the cost of supply and stacking the requisite quantity of manure/sludge and oil cake.

18.16.2 In Soil other than Ordinary Soil Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and/or ordinary soil in any hole, the different excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only. The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.
18.16.2.1 Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately.

18.16.2.2 The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge. If such places are outside initially leads, carriage for the extra lead shall be paid for separately.

18.16.2.3 The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 16 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

18.16.2.4 Measurements: The pit shall be enumerated. The volume of excavation in soil and other than ordinary soil shall be determined by reducing the stack volume of the relevant soil with respective percentage for voids specified in 18.14.2.2.

18.16.2.5 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, including mixing refilling, watering, dressing etc. but shall not include (a) cost of manure over sludge (b) cost of supplying and stacking of good earth for replacement and (c) the cost of carriage beyond initial lead for disposing off useless materials. The excavation other than that of ordinary soil shall be paid extra over and above the rate if excavation in ordinary soil.

18.17 M.S. FLAT IRON TREE GUARD
18.17.1 M.S. Iron Riveted Tree Guard
The tree guard shall be 600 mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

18.17.1.1 The tree guard shall be framed of 4 nos. 25 x 6 m M.S. flat 2 meter long excluding displayed outward at lower and upto an extent 10 cm and 8 nos. 25 x 3 mm vertical M.S. Flat Riveted to 3 Nos. 25 x 6 mm Flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. bolts and nuts. The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved branded manufacturer.

18.17.1.2 Measurement: The tree guard shall be enumerated.

18.17.1.3 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above.

18.17.2 M.S. Plat Iron Welded Tree Guard
The tree guard shall be 600 mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

18.17.2.1 The tree guard shall be framed of 4 nos. 25 x 6 m M.S. flat 2 meter long excluding displayed outward at lower and upto an extent 10 cm and 8 nos. 25 x 3 mm vertical M.S. Flat Riveted to 3 Nos. 25 x 6 mm Flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. bolts and nuts. The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved branded manufacturer.

18.17.2.2 Measurement and Rates: as per para 18.16.1.2 and 18.16.1.3

18.18 FILLING MIXTURE OF EARTH & SLUDGE OVER MANURE
18.18.0 The separately specified earth and sludge shall be broken down to particles of size not exceeding 6 mm in any directions before mixing. Good earth shall be thoroughly mixed with sludge over manure in specified proportions as directed by Engineer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and leveled.

18.18.1 Measurement
Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.
18.18.2 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above, but do not include the good earth, sludge or manure which will be paid separately.

18.19 EXCAVATION OF DUMPED STONE OR MALBA
18.19.1 Excavation operations shall include excavation and getting out water if required. During the excavation stone, brick bats and other foreign material if met shall be removed and stacked within 50 meter lead and 1.5 m lift. Such material as is declared unserviceable by the Engineer-in-Charge be disposed within 50 m. The excavated surface shall be neatly dressed and leveled.

18.19.2 Measurements
Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

18.19.3 Rate
The rate shall include the cost of all the labour and material involve in all the operations described above.

18.20 EXCAVATION IN BAJRI PATH
18.20.1 All excavated operations shall include excavation and stacking of serviceable and unserviceable material. Excavated surface of Bajri path shall be removed and stacked upto 50 meter lead and disposed material neatly dressed.

18.20.2 Measurements
Same as 18.18.2.

18.20.3 Rate
Same as 18.18.3.

18.21 EXCAVATION OF WATER BOUND MACADAM
18.21.1 All excavated operations shall include excavation, stacking of serviceable and unserviceable material. Excavation shall be straight and uniform in width. Soling stone and aggregate obtained from excavation of W.B.M. shall be stacked separately and unserviceable materials disposed off with lead upto 50 meter and lift upto 1.50 meter and neatly dressed.

18.21.2 Measurements
Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

18.21.3 Rate
The rate shall include the cost of all the labour and material involved in all the operations described above.

18.22 FLOODING THE GROUND WITH WATER AND MAKING KIARIES
18.22.1 The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

18.22.2 Measurements
Measurement shall be made in sqm. of area.

18.22.3 Rate
The rate shall be for 100 sqm of area and include the cost of all the labour and material involved in all the operations described above.
19. FORM WORK
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19.1 Form Work
19.1.1 General Requirement
Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support. It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete. Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

19.1.2 Design & Tolerance in Construction
Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance given below.

(a) Deviation from specified dimension of cross section of columns and beams
   +12 mm section of columns and beams
   -6 mm
(b) Deviation from dimensions of footings
   (i) Dimension in Plan
      + 50 mm
      -12 mm
   (ii) Eccentricity in plan
      0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
   (iii) Thickness
      ± 0.05 times the specified thickness.

(Note- these tolerances apply to concrete dimensions only, and not to positioning of vertical steel or dowels).

19.1.3 Material for Form Work
   (a) Propping and Centering: All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

19.1.4 (a) Centering/Staging: Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made form rolled structural steel sections.

(b) in case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.

(c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

19.1.5 Shuttering: Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Engineer-in-Charge shall be provided in the joints. Steel shuttering used or concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

(a) Runner Joists: RSJ, MS Channel or any other suitable section of the required size shall be used as runners.

(b) Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.

(c) Only steel shuttering shall be used, except for unavoidable portions and very small works for which 12 mm thick water proofing ply of approved quality may be used.
19.1.6 Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages. A typical detail of multistage shuttering is given in Fig. 9.

19.1.7 Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250) or as directed by the Engineer-in-Charge, so as to offset the subsequent deflection. For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

19.1.7.1 Typical arrangement of form work for 'beams, columns and walls' are shown in Figures 1 to 9 and form secured by wall ties is shown in Fig. 3. The figure from 4 to 9 are given in annexure.

19.1.8 Walls: The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. A typical wall form with the components identified is given in Fig. 1, 2 & 3. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs, some of the accessories used for wall form are shown in Fig. 3.
Fig. 2: Adjustable Curved Wall Form (Double Sided)

TYPICAL FIXING DETAILS OF WALL TIES

Fig. 3A: Wall Tie for Two Sided Shuttering

All Members are of Steel
### 19.1.9 Removal of Form work (Stripping Time)

In normal circumstance and where various types of cements are used, forms may generally be removed after the expiry of the following periods:

<table>
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<tr>
<th>Type of Form work</th>
<th>Minimum period Before Striking Form work for OPC 33 grade</th>
<th>Minimum period Before Striking Form work for OPC 43 grade</th>
<th>Minimum period Before Striking Form work for PPC</th>
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<tr>
<td>(a) Vertical form work to columns, walls, beams</td>
<td>16-24h</td>
<td>16-24 h</td>
<td>24-36 h</td>
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<tr>
<td>(b) Soffit form work to slabs (Props to be reaFIXED immediately after removal of formwork)</td>
<td>3 days</td>
<td>3 days</td>
<td>4 days</td>
</tr>
<tr>
<td>(c) Soffit form work to beams (Props to be reaFIXED immediately after removal of formwork)</td>
<td>7 days</td>
<td>7 days</td>
<td>10 days</td>
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<tr>
<td>(d) Props to slabs;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Spanning up to 4.5m</td>
<td>7 days</td>
<td>7 days</td>
<td>10 days</td>
</tr>
<tr>
<td>(2) Spanning over 4.5m</td>
<td>14 days</td>
<td>14 days</td>
<td>20 days</td>
</tr>
<tr>
<td>(e) Props to beams and arches;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Spanning up to 6m</td>
<td>14 days</td>
<td>14 days</td>
<td>20 days</td>
</tr>
<tr>
<td>(2) Spanning over 6m</td>
<td>21 days</td>
<td>21 days</td>
<td>30 days</td>
</tr>
</tbody>
</table>

**Note 1:** For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally if Portland Pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

**Note 2:** The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.
Note 3: For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

Note 4: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

Note 5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

Note 6: Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

19.2 Surface Treatment

19.2.1 Oiling the Surface: Shuttering gives much longer service life if the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections.

Typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3-4 uses and also in cases when shuttering has been stored for a long time, it should be recoated with mould oil before the next use.

The second categories of shuttering oils / leavening agents are Polymer based water soluble Compounds. They are available as concentrates and when used diluted with water in the ratio of 1:20 or as per manufacturer specifications. The diluted solution is applied by brush applications on the shuttering both of steel as well as ply wood. The solution is applied after every use.

19.2.2 The design of form work shall conform to sound Engineering practices and relevant IS codes.

19.3 Inspection of Form Work

The completed form work shall be inspected and approved by the Engineer-in-Charge before the reinforcement bars are placed in position.

Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discoloration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by Engineer-in-Charge.

Shuttering surface before concreting should be free from any defect/ deposits and full cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

19.3.1 Erection of Form Work (Centering and shuttering): Following points shall be borne in mind while checking during erection.

(a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.

(b) Material used should be checked to ensure that, wrong items/ rejects are not used.

(c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.

(d) (i) The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.

(ii) Sole plates shall be properly seated on their bearing pads or sleepers.

(iii) The bearing plates of steel props shall not be distorted. (iv) The steel parts on the bearing members shall have adequate bearing areas.
(e) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.

(f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, over turning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.

(g) The stacked materials shall be placed as catered for, in the design.

(h) When adjustable steel props are used. They should:
1. be undamaged and not visibly bent.
2. Have the steel pins provided by the manufacturers for use.
3. Be restrained laterally near each end.
4. Have means for centralizing beams placed in the foreheads.

(i) Screw adjustment of adjustable props shall not be over extended.

(j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/ elastic shorting of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/ clamped down after adjustment to prevent shifting.

(k) No member shall be eccentric upon vertical member.

(l) The number of nuts and bolts shall be adequate.

(m) All provisions of the design and/or drawings shall be complied with.

(n) Cantilever supports shall be adequate.

(o) Props shall be directly under one another in multistage constructions as far as possible.

(p) Guy ropes or stays shall be tensioned properly.

(q) There shall be adequate provision for the movements and operation of vibrators and other construction plant and equipment.

(r) Required camber shall be provided over long spans.

(s) Supports shall be adequate, and in plumb within the specified tolerances.

19.4 Measurements
19.4.1 General: The form work shall include the following:
(a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
(b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
(c) Bolts, wire, ties, clamps, spreaders, nails or any other items to hold the sheathing together.
(d) Working scaffolds ladders, gangways, and similar items.
(e) Filleting to form stop chamfered edges of splayed external angles not exceeding 20mm wide to beams, columns and the like.
(f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.
(g) Dressing with oil to prevent adhesion and
(h) Raking or circular cutting

19.4.2 Classification of Measurements: Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken
separately for the following.

(a) Foundations, footings, bases of columns etc. and for mass concrete

(b) Waifs (any thickness) including attached pilasters, buttresses, plinth and string courses etc.

(c) Suspended floors, roofs, landings, shelves and their supports and balconies.

(d) Lintels, beams, plinth beams, girders, bressummers and cantilevers.

(e) Columns, pillars, piers, abutments posts and struts.

(f) Stairs (excluding landings) except spiral staircase.

(g) Spiral staircases (including landings).

(h) Arches, Domes, vaults, shells roofs, arch ribs, curvilinear shaped folded plates

(i) Extra for arches, domes, vaults exceeding 6 m span other than curvilinear shaped

(j) Chimneys and shafts.

(k) Well staining.

(l) Vertical and horizontal fins individually or forming box, louvers and bands. Fascias and eaves board

(m) Waffle or ribbed slabs.

(n) Edges of slabs and breaks in floors and walls (to be measured in running meters where below 200 mm in width or thickness).

(o) Cornices and mouldings.

(p) Small surfaces, such as cantilevers ends, brackets and ends of steps, caps and boxes to pilasters and columns and the like.

(q) Chullah hoods, weather shades, chajjas, corbels etc. including edges and

(r) Elevated water reservoirs.

19.4.3 Centering, and shuttering where exceeding 3.5 meter height in one floor shall be measured and paid for separately.

19.4.4 Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.

19.4.5 No deductions from the shuttering due to the openings/ obstructions shall be made if the area of each openings/ obstructions does not exceed 0.4 square meter. Nothing extra shall be paid for forming such openings.

19.4.6 Form work of elements measured under categories of arches, arch ribs, domes, spiral staircases, well staining, shell roofs, curvilinear folded plates & curvilinear eaves board, circular shafts & chimneys shall not qualify for extra rate for circular work.

19.4.7 Extra for circular work shall be admissible for surfaces circular or curvilinear in plan or in elevation beyond the straight edge of supporting beam in respective mode of measurement. However, there may be many different types of such structures. In such cases, extra payment shall be made judiciously after deducting areas where shuttering for circular form work is not involved.

19.5 Rate
The rate of the form work includes the cost of labour and materials required for all the operations
ANNEXURE

TYPICAL STANDARD UNITS OF FORM WORK
(CENTRING & SHUTTERING)

Fig. 4: Typical Standard Units of Form Work

TYPICAL STANDARD UNITS OF FORM WORK
(CENTRING & SHUTTERING)
Fig. 4: Typical Standard Units of Form Work

TYPICAL COMPONENTS OF FORM WORK

A. ANGLE TRASONE
B. TUBULAR TRANSION
C. DIAGONAL
D. RIG UP BRACKETS
E. ANGLE TIE
F. RIG UP HELD BASE
Fig. 5: Typical Components of Form Work

TYPICAL ARRANGEMENT OF COLUMN FORM WORK

Fig. 6A: Four Sides Adjustable Column Form  Fig. 6B: Two Sides Adjustable Column Form  6C: Column Form with Adjustable Shuttering Wall Form Type Panels
Fig. 7: Typical Column Shuttering

Fig. 8: Typical Detail of Beam Head and Stiffner
TYPICAL DETAILS OF MULTI STAGE SHUTTERING

Fig. 9A: Suspended Floor – Multi Stage Shuttering (Vertical Section)

Fig. 9B: Typical Details of Multi-State Shuttering
20. WATER HARVESTING, RECYCLE AND REUSE WASTEWATER
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Notes for Specifications

20 General: -
To supplement the ever growing shortage of protected, Pure and safe water supply for human consumption rainwater is an ideal source which can be conserved and used in a useful manner by the people. The amount of rainfall available varies from region to region. Each area has to develop its own method and system to conserve, store and use it to suit its requirement and local conditions. there are several methods by which rain after can be stored, used and conserved. Each system depends on the amount of precipitation, the period in which the rainfall occurs in year and the physical infrastructure for example, space available to store the water, etc.

20.1:- From where to harvest rain:-
Rain water harvesting can be harvested from the following surfaces

(A) **Roofops**: If building with impervious roofs is already in place, the catchment area is effectively available free charge and they provide a supply at the point of consumption.

(B) **Paved and unpaved areas** i.e., landscapes, open field, parks, stromwater drains, roads and pavement and other open areas can be effectively used to harvest the run off. The main advantage in using ground as collection surface is that water can be collected from a larger area. This picture advantageous in area of low rainfall.

(C) **Water bodies**: the potential lakes, tanks and ponds to store rainwater is immense. The harvested rainwater can not only be used to meet water requirement of the city, it also recharges ground water aquifers.

(D) **Stromwater drains**: Most of the residential colonies have proper network of stromwater drains. If maintained neatly, these offer a simple and cost effective means for harvesting rainwater.

20.2 **COMPONENT OF A RAINWATER HARVESTING SYSTEM**
A rainwater harvesting system comprises components of various stages- transporting rainwater through pipes or drains, filtration, and storage in tanks for reuse or recharge. The common components of rainwater harvesting system involved in these stages are illustrated here.

1.- **Catchments**: The catchments of a water harvesting system are the surface which directly receives the rainfall and provides water to the system. It can be a paved area like a terrace or court yard of building, or an unpaved area like a lawn or open ground. A roof made of reinforced cement concrete (RCC), galvanized iron or corrugated sheet can also be used for water harvesting.

2 :- Coarse mesh at the roof to prevent the passage of debris.

3:- **Gutters**: Channel all around the edge of a sloping roof to collect and transport rainwater to the storage tank. The size of gutter should be according to the flow during the highest intensity rain. It is advisable to make them 10 to 15 percent oversize. Gutters need to be supported so they do not sag or fall off when loaded with water. The way in which gutters are fixed depend on the construction of the house it is possible to fix iron or timber bracket into the wall, but for houses having wider eaves, some method of attachment to the rafters is necessary.

4. **Conduits**
Conduits are pipelines or drains that carry rainwater from the catchment or rooftop area to the harvesting system. Conduits can be of any material like polyvinyl chloride (PVC) or galvanized iron (GI) material that are commonly available.

5. **First flushing**
A first flush device is a valve that ensures that runoff from the first spell of rain is flushed out and does not enter the system. This need to be done since the first spell of rain carries a relatively larger amount of pollutants from the air and catchment surface.
6. Storage facility
There are various option available for the construction of storage tanks with respect to the shape, size and the material of construction.
Shape: cylindrical, rectangular and square.

7. Recharge structures
Rainwater may be charged into the ground water aquifers through any suitable structure like dug wells, borwells, recharge trenches and recharge pits.

Various recharge structures are possible – some which promote the percolation of water through soil strata at shallower depth (e.g. recharge trenchers, permeable pavements) where other conduct water to greater depths from where it joins the groundwater (e.g. recharge wells). At many locations, existing structure like well, pits and tanks can be modified as recharge structure, eliminating the need to construct any structures afresh.

20.3 There are two board approaches to harvesting water:-
(a) Storing rainwater for direct use
(b) Recharging groundwater aquifers

In Madhya Pradesh the total annual rainfall occurs only during 3 or 4 months of mansoon. The water collected during the mansoon has to be stored throughout the year; which means that huge volumes of storage containers would have to be provided. Hence it is more feasible in urban area to use rainwater for recharging groundwater aquifers rather than for storage.

20.4 Rainwater harvesting method for urban areas:-
(a) Recharge pit
(b) Recharge Trench
(c) Tube well
(d) Recharge Well

In urban areas, rain water available from roof tops of buildings, paved and unpaved areas goes waste. This water can be recharged to aquifer and can be utilized gainfully at the time of need. The rain water harvesting system needs to be designed in a way that it does not occupy large space for collection and recharge system. A few techniques of roof top rain water harvesting in urban areas are described below:-

20.4.1 Roof top rain water Harvesting Through Re-charge pit
(a) In alluvial areas where permeable rocks are exposed on the land surface or at very shallow depth, rooftop rain water harvesting can be done through recharge pit

(b) The technique is suitable for building having a roof area of 100 sq.m. and are constructed for recharging the shallow aquifers.

(c) Recharge pit may be of any shape and size and are generally constructed 1 to 2 m. wide and 2 and 3m. Deep which are back filling with boulders (5-20 cm), gravels (5-10 mm) and coarse sand (1.5-2mm) in graded from - Boulders at bottom, gravels in between and coarse sand at the top so that the silt content that will come with runoff will be deposited on the top of coarse sand layer and can easily be removed. For smaller roof area, pit may be filled with broken bricks/cobbles.

(d) A mesh should be provided at the roof so that leaves or any other solid waste/debris is prevented from entering the pit and a desilting/collection chamber may also be provided at the ground to arrest the flow of finer particles to the recharge pit

(e) The top layer of sand should be cleaned periodically to maintain the recharge rate.

(f) By-Pass arrangement be provided before the collection chamber to reject the first showers.

20.4.2 Roof top rain water Harvesting Through Recharge Trench
(a) Recharge trenches are suitable for buildings having roof area of 200-300 sq.m. and where permeable strata is available at shallow depths.
(b) Trench may be 0.5 to 1 m wide, 1 to 1.5 m deep and 10 to 20 m long depending upon availability of water to be recharged.

(c) These are back filling with boulders (5-20 cm), gravels (5-10 mm) and coarse sand (1.5-2 mm) in graded from bottom, gravels in between and coarse sand at the top so that the silt content that will come with runoff will be deposited on the top of coarse sand layer and can easily be removed.

(d) A mesh should be provided at the roof so that leaves or any other solid waste/debris is prevented from entering the pit and a desilting/collection chamber may also be provided at the ground to arrest the flow of finer particles to the recharge pit.

(e) By-Pass arrangement be provided before the collection chamber to reject the first showers.

(f) The top layer of sand should be cleaned periodically to maintain the recharge rate.

20.4.3 Roof top Rain Water Harvesting through Existing Tube well.
(a) In area where the shallow aquifers have dried up and existing tube wells are tapping deeper aquifers, roof top rain water harvesting through existing tube well can be adopted to recharge the deeper aquifers.

(b) PVC pipes of 10 cm dia are connected to roof drains to collect rain water. The first roof runoff is let off through the bottom of drain pipe. After closing the bottom pipe, the rain water of subsequent rain showers is taken through a T to an online PVC filter. The filter may be provided before water enters the tube well. The filter is 1-1.2 m in length and is made up of PVC pipe. Its diameter should vary depending on the area of roof, 15 cm if roof area is less than 150 sq m. and 20 cm if the roof area is more. The filter is provided with a reducer of 6.25 cm on both the sides. Filter is divided into three chambers by PVC screens so that filter material is not mixed up. The first chamber is filled up with gravel (6-10 mm), middle chamber with pebbles (12-20 mm) and last chamber with bigger pebbles (20-40 mm).

(c) If the roof area is more, a filter pit may be provided. Rain water form roof is taken to collection/desilting chambers located on ground. These collection chambers are interconnected as well as connected to the filter pit through pipes having a slope of 1:15. The filter pit may very in shape and size depending upon available run off are back-filling with graded material, boulder at the bottom, gravel in the middle and sand at the top with varying thickness (0.30-0.50 m) and may be separated by screen. The pit is divided into two chambers, filter material in one chamber and other chamber is kept empty to accommodate excess filtered water and to monitor the quality of filtered water. A connecting pipe with recharge well is provided at the pit for recharging of filtered water through well.

20.1.4 Roof top Rain Water Harvesting through Trench with Recharge Well
(a) In area where the surface soil is impervious and large quantities of roof water or surface runoff is available within a very short period of heavy rainfall, the use of trench/pit is made to store the water in a filter media and subsequently recharge to groundwater through specially constructed recharge wells.

(b) The technique is ideally suited for area where permeable horizon is within 3 m below ground level.

(c) Recharge well of 100-300 diameter is constructed to a depth of at least 3 to 5 m below the water level. Based on the lithology of the area well assembly is designed with slotted pipe against the shallow and deeper aquifer.

(d) A lateral trench of 1.5 to 3 m width and 10 to 30 m length, depending upon the availability of water is constructed with the recharge well in the centre.

(e) The number of recharge wells in the trench can be decided on the basis of water availability and local vertical permeability of the rocks.

(f) The Trench is backfilled with boulders, gravels and coarse sand to act as a filter media for the recharge wells.

(g) If the aquifer is available at greater depth say more than 20 m, a shallow shaft of 2 to 5 m diameter and 3 to 5 meters deep may be constructed depending upon availability of runoff. Inside the shaft a
recharge well of 100-300mm dia is constructed of recharging the available water to the deeper aquifers. At the bottom of the shaft media is provided to avoid choking of recharge well.

**Runoff coefficients**

Runoff coefficient is the factor which accounts for the fact that all the rainfall falling on a catchment cannot be collected. Some rainfall will be lost from the catchment by evaporation and retention on the surface itself.

<table>
<thead>
<tr>
<th>Type of Catchment</th>
<th>Table 3.1 Runoff coefficients for various surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof Catchments</td>
<td></td>
</tr>
<tr>
<td>- Tiles</td>
<td>0.8-0.9</td>
</tr>
<tr>
<td>- Corrugated metal sheets</td>
<td>0.7-0.9</td>
</tr>
<tr>
<td>Ground surface coverings</td>
<td></td>
</tr>
<tr>
<td>- Concrete</td>
<td>0.6-0.8</td>
</tr>
<tr>
<td>- Bricks pavement</td>
<td>0.5-0.6</td>
</tr>
<tr>
<td>Untreated ground catchments</td>
<td></td>
</tr>
<tr>
<td>- Soils on slopes less than 10%</td>
<td>0.0-0.3</td>
</tr>
<tr>
<td>- Rocky natural catchments</td>
<td>0.2-0.5</td>
</tr>
</tbody>
</table>

Runoff is calculated by the formula \( A \times R \times C = \)

Where \( A \) = Area of Runoff rooftop catchment

\( R \) = Peak rainfall

\( C \) = Runoff coefficients

---

20.5 Material used in Rainwater harvesting

20.5.1 Readymade filter for water harvesting:- Various type of water harvesting filter are available in market any approved and tested filter shall be used.

PVC Pipe shall be as per IS 4985

20.5.2 Gravel: It shall consist of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, loam, adherent coating, alkali, vegetable matter and other deleterious substances. Gravel of size 6 mm to 10 mm is used in water harvesting.

20.5.3 Brick bats: Brick bats shall be obtained by breaking well burnt or over burnt dense brick/brick bats. They shall be homogeneous in texture, roughly cubical in shape and clean.

20.5.4 Pebble: It is also consist of natural occurring in riverbed. Pebble of size 12 mm to 20 mm and 20 mm to 40 mm are generally useful for water harvesting purpose. Sand it shall be as per specification in chapter 2.

20.6 Care to taken in rain water harvesting

Water conservation technique discussed above shall be constructed with due care taking following precautions:

1. No sewage or waste water should be admitted into the system.

2. No waste water from areas likely to have oil, grease or other pollutants should be connected to the system.

3. Each structure / well shall have an inlet chamber with a silt trap to prevent any silt from finding its way into the sub soil water.

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4. The well should be terminated at least 5 m above the natural static sub soil water at its highest level so that the incoming flow passes thorough the natural ground condition and prevents contamination hazards.

5. No recharges structure or a well shall be used for drawing water for any purpose.

20.7 Domestic Waste Water
Types of waste water are given below:

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Black Water</td>
<td>Water from flush toilets (faeces and urine with flush water)</td>
</tr>
<tr>
<td>2</td>
<td>Grey Water</td>
<td>Water from the kitchen, bathroom, washing machine (does not contain faeces and urine)</td>
</tr>
<tr>
<td>3</td>
<td>Yellow Water</td>
<td>Urine from urinals (with or without water for flushing)</td>
</tr>
<tr>
<td>4</td>
<td>Brown Water</td>
<td>Black water without urine or yellow water</td>
</tr>
</tbody>
</table>

20.7.1 Black Water
Black Water is water from toilets with flush water, faces (brown water) and urine (yellow Water). It consist a high concentration of organic carbon and concentration of nitrogen, phosphorus and pathogens.

20.7.2 Grey Water
Grey water comes from activities like washing of cloths, bathing and cooking and contains synthetic detergents. Kitchen waste consists of food residues as well as type of grease (fat).

20.8 System of Treatment of waste water
Type of treatment
- DEWATS
- Reed bed system
- Septic tank with soak pit or
- Soil biotechnology
- Improved septic tank

20.8.1 DEWATS Component of system
DEWATS applications are based on four basic treatment modules, which are combined according to specific requirements. These include two post- treatment methods in the reed bed system and in ponds.

1. Primary treatment, which includes pre-treatment and sedimentation in settlement tank or septic tank.
2. Secondary anaerobic treatment in baffled reactors
3. Tertiary aerobic/anaerobic treatment in reed bed system.
4. Aerobic treatment in ponds.

20.8.2 Grey water recycling
Treating household grey water
At the household level, grey water is treated by constructing plated filler. The amount of grey water output is estimated at 180 liter per day. A reed bed of 1 m width, 2 m length and 0.6 m depth (1 per cent slope at the bottom) provides retention for a volume of 1.2 cu m of wastewater. When filled with gravel with about 30 per cent pore space, the free volume available was 0.36 cu m or 360 liter. This is sufficient to provide a retention time of up to two days for the wastewater. However, actual retention time will depend on the frequency and the number of users.

The pit is lined with polythene and a brick wall is built around it to prevent the inflow of surface run-off into the unit. At the inlet, a plastic tub is placed to serve as the inlet chamber. Bath water is filled into this tub. The suspended particles become sediment and wastewater overflows from this tub to the inlet of the remediation chamber, where coarse gravel (3 cm) has been filled. The rest of the unit is filled with small gravel (1 cm) up to the outlet end of the bed. At the bottom, a perforated pipe is laid, to collect the treated water. At the outlet, the water is led into a small tank and stored for irrigation.

20.8.3 Improved septic tank:
Screened (through a screen with bars 25-50 mm apart) wastewater is diverted to be septic tank which is collected in a serial of connection chamber is divert to the improved septic tank, which is provided with four chambers, each 1m in length and 1.5 m in depth.

The incoming raw sewage settles in the first chamber and the overflow moves to the next chambers through the 75 mm PVC pipe provide at the top of each chamber. The pipe helps to mix the raw sewage with already existing activated sludge, which is enriched in microorganisms for digesting it. In order to enhance the function of the microorganisms, a biocatalyst is added to the septic tank. The biocatalyst, which are in crystal form, speed up the reaction but are not affected themselves. Apart from biocatalyst – in order to improve the treatment process – an anaerobic up flow filter is also installed.

Anaerobic filter are provided in the third chamber of the septic tank. The filter act as an ideal breeding ground for the microbes and result in effective treatment of incoming wastewater. Most of the treatment in the septic tank takes place under anaerobic condition. Hence, by adding a polishing pond to the system, aerobic reaction is also incorporated. In the polishing pond the treated water is exposed to sunlight, which helps in reducing the pathogen count. Finally, this treated water is used for irrigation.

Above plant is sufficient for treatment of wastewater 600 liter per day

**Improved Septic tank**

The Gravel shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks.

**4 Rates**
Rates include cost of material & labour
21. BUILDING WATER SUPPLY
## Contents

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<td>21.18</td>
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<td>21.19</td>
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<tr>
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<td>CUTTING HOLES IN R.C.C. FLOORS (UPTO 15 X 15 CM)</td>
</tr>
<tr>
<td>21.21</td>
<td>CUTTING CHASES IN MASONRY WALLS</td>
</tr>
</tbody>
</table>
## 21.0 WATER SUPPLY

### 21.1 APPLICABLE CODES:-

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<th>Title</th>
</tr>
</thead>
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<td>IS 554</td>
<td>Pipe threads where pressure tight joints are required on the threads. Dimensions, tolerances and designation.</td>
</tr>
<tr>
<td>IS 778</td>
<td>Specification for copper alloy gate, and check valves for water works purposes.</td>
</tr>
<tr>
<td>IS 779</td>
<td>Water meters (domestic type) – Specification</td>
</tr>
<tr>
<td>IS 780</td>
<td>Specification for sluice valves for water works purposes (50 to 300 mm size)</td>
</tr>
<tr>
<td>IS 781</td>
<td>Specification for cast copper alloy screw down bib taps and stop valves for water services.</td>
</tr>
<tr>
<td>IS 782</td>
<td>Specification for caulking lead.</td>
</tr>
<tr>
<td>IS 909</td>
<td>Underground fire hydrant, sluice valve type-Specification</td>
</tr>
<tr>
<td>IS 1239 (Part 1)</td>
<td>Steel tubes tubular and other wrought steel fittings, Part 1 – Steel tubes- Specification.</td>
</tr>
<tr>
<td>IS 1239 (Part 2)</td>
<td>Specification for mild steel tubes tubular and other wrought steel fittings, Part-2 Mild street tubular and other wrought steel pipe fittings.</td>
</tr>
<tr>
<td>IS 1536</td>
<td>Centrifugally cast (spun) iron pressure pipes for water gas and sewage – Specification.</td>
</tr>
<tr>
<td>IS 1537</td>
<td>Specification for vertically cast iron pressure pipes for water, gas and sewage.</td>
</tr>
<tr>
<td>IS 1538</td>
<td>Cast iron fittings for pressure pipes for water, gas and sewage – Specification.</td>
</tr>
<tr>
<td>IS 1703</td>
<td>Water fittings – copper alloy float valves (horizontal plunger type) – Specification</td>
</tr>
<tr>
<td>IS 2692</td>
<td>Ferrules for water services – Specification.</td>
</tr>
<tr>
<td>IS 3950</td>
<td>Specification for surface boxes for sluice valves</td>
</tr>
<tr>
<td>IS 4736</td>
<td>Specification for Hot-dip Zinc Coatings on mild steel tubes</td>
</tr>
<tr>
<td>IS 5312 (Part 1)</td>
<td>Swing type reflex (non return) valves for water works purposes. Part 1- Single door pattern.</td>
</tr>
<tr>
<td>IS 5312 (Part 2)</td>
<td>Swing type reflex (non return) valves for water works purposes. Part 2 – Multi door pattern.</td>
</tr>
<tr>
<td>IS 5382</td>
<td>Rubber sealing rings for gas mains, water mains and sewers</td>
</tr>
<tr>
<td>IS 9762</td>
<td>Specification for polyethylene floats (spherical) for float valves.</td>
</tr>
<tr>
<td>IS 9763</td>
<td>Plastic Bib taps and stop valves (rising spindle) for cold water services – specification.</td>
</tr>
<tr>
<td>IS 15450</td>
<td>PE-AL-PE Pipes for hot and cold water supplies-Specifications</td>
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<tr>
<td>IS 15778</td>
<td>Chlorinated Polyvinyl Chloride (CPVC) pipes for potable hot and cold water distribution supplies-specifications.</td>
</tr>
<tr>
<td>IS 15801</td>
<td>Polypropylene- Random Copolymer Pipes for hot and cold water supplies – Specifications.</td>
</tr>
</tbody>
</table>
21.2 GENERAL REQUIREMENTS

21.2.1 Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the contractor. Nothing extra shall be paid for it, except where otherwise specified.

21.2.2 All water supply installation work shall be carried out through licensed plumbers.

21.2.3 It is most important to ensure that wholesome water supply provided for drinking and culinary purposes, is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be construed a permissible substitute for complete absence of cross-connection.

21.2.4 Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only into a cistern, and by a pipe or fitting discharging into the air gap at a height above the top edge of the cistern equal to twice its nominal bore, and in no case less than 15 cm.

21.2.5 No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such nature that can cause undue deterioration of the pipe.

21.2.6 Where the laying of any pipe through fouled soil or previous material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

21.2.7 The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non return valves shall not be relied upon to prevent such back flow.

21.2.8 All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water, damage to property and the risk of contamination of the water conveyed.

21.2.9 In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if
required, and to avoidance of airlocks, noise transmission and unsightly arrangement.

21.2.10 To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing material or otherwise.

21.2.11 Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.

21.2.12 Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost on traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping have to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

21.2.13 Where the service pipe is of diameter less than 50mm the stop valves shall be of the screw down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

21.2.14 In flats and tenements supplied by a common service pipe, a stop valve shall be fixed to contact the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps, so as to minimize interruption of the support during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.

21.2.15 Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.

21.2.16 Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In case where pumping is required, properly protected storage tank of adequate capacity shall be provided to feed the pump.

21.2.17 Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

21.2.18 Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided. Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have
easy bends, and where quietness is particularly desired, holder bats or clamps shall be insulated from the piping by suitable pads.

21.2.19 The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

21.2.20 All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

21.2.21 When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joists.

21.2.22 Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except on direct connection for culinary or drinking requirements.

21.2.23 No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall have supply from storage tank.

21.2.24 No service or supply pipe shall be connected directly to any hot-water system or to any apparatus used for heating other than through a feed cistern thereof.

21.3 MATERIALS

21.3.1 The standard size of brass or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Engineer-in-Charge and all supplies made according to the approved samples.

All cast iron fittings shall be sound and free from laps, blow holes and pitting. Both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging, stopping or patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the water way of the fittings shall not be less than area of the nominal bore, chromium plating wherever specified shall be of 0.3 micron. The chromium shall never be deposited on brass unless a heavy coating of nickel is interposed. In the case of iron a thick coat of copper shall first be applied, then one of nickel and finally the chromium. In finish and appearance the plated articles when inspected
shall be free from plating defects such as blisters, pits roughness and unplated areas and shall not be stained or discolored. Before fitting is plated, the washer plate shall be removed from the fittings, the gland packing shall be protected from the plating solution.

21.3.2 Ball Valve (Brass)

The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703. The ball valve shall be of following two classes:

21.3.2.1 High Pressure: High pressure float valves are indicated by the abbreviation ‘HP’ and are designed for use on mains having pressure of 0.175 MPa or above.

21.3.2.2 Low Pressure: Low Pressure float valves are indicated by the abbreviation ‘LP’ and are designed for use on mains having a pressure up to 0.175 MPa.

21.3.2.3 The ball valves shall be of following nominal sizes 15mm, 20mm, 25mm, 32 mm, 40 mm and 50mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS 9762.

21.3.3 Bib Taps and Stop Valve

Brass : A bib tap is a draw off tap with a horizontal inlet and free outlet and a stop valve is a valve with suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of screw down type and shall conform to IS 781. The closing device shall work by means of disc carrying a renewable non-metallic washer which shuts against water pressure on a seating a right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anti-clock wise direction.

The bib tap and stop valve shall be polished bright. The minimum finished weights of bib tap and stop valve shall be as specified in Table 21.2.

<table>
<thead>
<tr>
<th>Size(mm)</th>
<th>Bib Taps</th>
<th>Stop valves</th>
<th>Mixed End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Internally Threaded</td>
<td>Externally Threaded</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.250</td>
<td>0.220</td>
<td>0.250</td>
</tr>
<tr>
<td></td>
<td>Kg</td>
<td>Kg</td>
<td>Kg</td>
</tr>
<tr>
<td>8</td>
<td>0.300</td>
<td>0.300</td>
<td>0.350</td>
</tr>
<tr>
<td>10</td>
<td>0.400</td>
<td>0.330</td>
<td>0.400</td>
</tr>
<tr>
<td>15</td>
<td>0.750</td>
<td>0.675</td>
<td>0.750</td>
</tr>
<tr>
<td>20</td>
<td>1.250</td>
<td>1.180</td>
<td>1.300</td>
</tr>
<tr>
<td>25</td>
<td>1.300</td>
<td>1.250</td>
<td>1.300</td>
</tr>
</tbody>
</table>

**TABLE 21.2**

Minimum Finished Mass of Bib taps and Stop Valves
<table>
<thead>
<tr>
<th>Size</th>
<th>Bib Taps</th>
<th>Minimum Finished Mass</th>
<th>Stop valves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Internally</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Threaded</td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>1.680</td>
<td>1.800</td>
</tr>
<tr>
<td>40</td>
<td>2</td>
<td>2.090</td>
<td>2.250</td>
</tr>
<tr>
<td>50</td>
<td>3</td>
<td>3.700</td>
<td>3.850</td>
</tr>
</tbody>
</table>

In case these are required to be nickel plated, the plating shall be of the first quality with a good thick deposit of silvery whiteness capable of taking high polish which will not easily tarnish or scale.

21.3.4 Ferrules

The ferrules for connection with C.I. main shall generally conform to IS 2692. It shall be of non ferrous materials with a C.I. bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.

21.3.5 Fire Hydrants

The hydrant shall conform to IS 909 and shall consist of the following components.

(a) Body    (d) Gland    (g) Valve  
(b) Bonnet  (e) Spindle Cap (h) Screeded Outlet  
(c) Spindle (f) Spindle Nut (i) Outlet and Chain  

The body, bonnet, gland, outlet cap and spindle cap and shall be of good quality cast iron grade FG 200 of IS 210. Outlet, seat for valve, valve, spindle nut, check nut shall be made of copper alloy as per IS 909.

21.3.6 Gate Valve – Gun Metal

These shall be of the gun metal fitted with wheel and shall be of gate valve type opening full way and of the size as specified. These shall generally conform to IS 778.

21.3.7 Pig Lead

Pig lead shall be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to is 782 for caulkimg lead in all respects.

21.3.8 Lead Wool

Lead wool shall conform to IS 782 in all respects. Lead wool shall consist of fine strands or plated ribbons of lead. The cross-section of the individual strands shall be flat. The dimensions in the sectional plane shall not be less than 0.13mm and not more than 0.90mm and the rope shall be supplied in
minimum lengths of two metres and the maximum length in any one package shall be such that the package does not weigh more than 50 Kg.

21.3.9 Non-Return Valve (Gun Metal)

A non return valve permits water to flow in one direction only on the ascending part of the main to check return flow. The non-return valve shall be of Gun metal and shall be of horizontal or vertical flow type as specified.

The valve shall be of quality approved by the Engineer-in-Charge and shall generally conform to IS 778.

21.3.10 Pipes and Specials

Pipes and specials may be of any of the following types as specified:

(a) Cast iron centrifugally cast (spun) – IS 1536
(b) Galvanised steel – IS 1239 & IS 4736
(c) PE-AL-PE Pipes – IS 15450
(d) PP-R Pipes – IS 15801
(e) CPVC Pipes – IS 15778

In choosing the material for piping and fittings, account shall be taken of the character of the water to be conveyed through it, the nature of the ground in which the pipes are to be laid and the relative economics.

21.3.11 Pipes – Centrifugally Cast (Spun) Iron Pipes

21.3.11.1 The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be of cast iron cast centrifugally and vary in diameters from 80 mm to 1050 mm. These shall be of class LA, class A and class B, as specified. Pipes shall be tested hydrostatically at the pressure specified in table 21.3 & 21.4 Tolerances on specified dimensions shall be as prescribed in Appendix A.

21.3.11.2 Specials: The specials shall conform to IS 1538. The hydraulic test pressure of each class shall be as detailed in Table 21.5. Tolerances on specified dimensions shall be as prescribed in Appendix B.

### TABLE 21.3

<table>
<thead>
<tr>
<th>Class</th>
<th>Hydrostatic Test pressure for centrifugally cast socket &amp; spigot pipes in MPa</th>
<th>Hydrostatic Test pressure for work in MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upto DN 600</td>
<td>DN 700 &amp; above</td>
</tr>
<tr>
<td>LA</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>A</td>
<td>3.5</td>
<td>2.0</td>
</tr>
<tr>
<td>B</td>
<td>3.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>
### TABLE 21.4

<table>
<thead>
<tr>
<th>Class</th>
<th>Upto DN 600</th>
<th>DN 700 &amp; above</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>2.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

### TABLE 21.5

<table>
<thead>
<tr>
<th>Nominal – Diameter</th>
<th>Fitting without branches or with branches not greater than half the principal diameter</th>
<th>Fitting with branches greater than half the principal Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto and including 300mm</td>
<td>2.5 (25)</td>
<td>2.5 (25)</td>
</tr>
<tr>
<td>Over 300mm and upto and including 600mm</td>
<td>2.0 (20)</td>
<td>2.0 (20)</td>
</tr>
<tr>
<td>Over 600mm and upto and including 1500mm</td>
<td>1.5 (15)</td>
<td>1.0 (10)</td>
</tr>
</tbody>
</table>

21.3.12 Pipes-Galvanised Iron

21.3.12.1 The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HRIW or HFW screwed and socketed conforming to the requirements of IS 1239 Part-1 for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

21.3.12.2 Galvanising shall conform to IS 4736 : The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare batches, black spots, pimples, lumping runs, rust stains bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surfaces flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

21.3.12.3 The dimensions and weights of pipes and sockets and tolerances shall be as prescribed in Appendix “C”.

21.3.12.4 All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

21.3.12.5 All tubes shall withstand a test pressure of 50 Kg/sq.cm without showing defects of any kind.

21.3.12.6 Fittings: The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.
21.3.13 Shower Rose Brass
The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as required.

21.3.14 Sluice Valves-Brass/Gun Metal
The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non-raising screw type up to 300 mm size and raising or non-raising screw type above 300 mm with either double flange or double socket ends and cap or hand wheel. These shall in all respects comply with the Indian Standard Specification IS 14846 for valves up to and including 300 mm size and for valves above 300 mm size Class I sluice valves are used for maximum working pressure of 10 Kg/sq.cm (100 meter head) and class II sluice valves for 15 Kg/sq.cm (150 metre head).

The body, domes covers, wedge gate and stuffing box shall be of good quality cast iron, the spindle of bronze, and the nut and valve seats of leaded tin bronze. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe.

The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

21.3.15 Surface Box
This shall be of cast iron, well made and free from casting and other defects. All sharp edges shall be removed and finished smooth. The shape and dimensions for surface boxes for stop cocks, sluice valves, fire hydrants, water meters etc shall be as per relevant IS codes.

The C.I. surface boxes shall be coated with a black bituminous composition except in case of fire hydrants where the cover of the surface box shall be painted with two coats of rust resisting bright luminous yellow paint for clear visibility during night.

21.3.16 Water Meter (Domestic Type)

21.3.16.1 Water meters shall be selected according to flow to be measured and not necessarily to suit a certain size of main. The following points shall govern the selection of meters.

(a) The maximum flow shall not exceed the nominal capacity of the meter.

(b) The continuous flow shall be not greater than the continuous running capacity rating.

(c) The minimum flow to be measured shall be within minimum starting flows.
21.3.16.2 Inferential water meter has the same accuracy as the semi-positive type at higher flows; it passes unfiltered water better than a semi-positive meter and is lower in cost.

21.3.16.3 Special care is necessary in selecting the most suitable meter where large rates of flow may exist for short periods. The normal working flow shall be well within the continuous running capacity specified in IS 779, as high rates of flow over short period may cause excessive wear if the meter chosen is too small for the duty.

21.3.16.4 Owing to the fine clearances in the working parts of meters, they are not suitable for measuring water containing sand or similar foreign matter, and in such cases a filter or dirt box of adequate effective area shall be fitted on the upstream side of the meter. It shall be noted that the normal strainer fitted inside a meter is not a filter and does not prevent the entry of small particles, such as sand.

21.3.16.5 Water meters and their parts, especially parts coming in continuous contact with water shall be made of materials resistant to corrosion and shall be non-toxic and non-training. Use of dissimilar metals in contact under water shall be avoided as far as possible in order to minimize electrolytic corrosion.

21.3.16.6 Body: The body of water meter shall be made either from Type A or Type B materials as specified below:

Type A: The body of water meters shall be made from bronze, brass or any other corrosion resistant material e.g. Grey iron castings, blackheart malleable iron, pherodial graphite iron casting.

Type B: The body of the water meters shall be made from suitable plastics.

Note: Plastics shall have following qualities:

(i) It shall not affect the portability of water.

(ii) Elongation, 15 per cent, Min. of a specimen of length 150 mm (for procedure to determination of elongation).

(iii) Water absorption on immersion for 24 hours should not exceed 0.6 per cent by weight (for procedure of determination of water absorption).

(iv) It shall be capable of withstanding temperature up to 55°C without undergoing deformation or softening and becoming unsatisfactorily in performance.

21.3.16.7 Registration Box:

Registration box of water meters of Type A shall be made from bronze brass, aluminum alloy or suitable plastics. Registration box of water meters of Type B shall be made from suitable plastics or aluminum alloys. The registration box of dry dial water meters shall be provided with one or two escape holes for minimizing the accumulation of condensed water.
21.3.16.8 **Cap:**

Cap of water meters of Type A shall be made from brass, bronze, aluminum alloy suitable plastics. The cap of water meters of Type B shall be made of plastics or aluminum alloy. Where the cap and registration box are integral, the materials for cap may be the same as used for registration box. The cap shall be so designed and fixed to the registration box as to avoid entry of water and dirt. The transparent window which covers the dial shall be inserted from the inside into the cap. The protective lid shall be secured by a robust hinge or other suitable method of robust construction.

21.3.16.9 **Locking Arrangement:**

Provision shall also be made to lock the lid. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use conjunction with padlocks, the hole provided for padlocks shall be of a diameter not less than 4 mm.

21.3.16.10 **Wiper:**

Where so required for dry-type water meters the transparent window covering the dial shall be provided with a wiper on the inner side for wiping off condensed water.

21.3.16.11 **Connecting Arrangements:**

The meter casing shall be fitted in the pipe line by means two conical or cylindrical nipples or tail pieces with connecting nuts which shall be provided with each meter. The nipples of water meters of Type A shall be made of the same materials as specified for body. Nipples of water meters of Type B shall be made of the same materials as specified for the body where they are integral with the body of the water meters: where they are separate, they shall be made of malleable iron, galvanized steel or suitable plastics. The nuts shall be of the same material as used for nipples. The internal diameter of the nipple where it connects the pipe line shall be equal to that corresponding to the nominal size of the meter. The threads on the connection shall conform to IS 779. The minimum length of the threads shall be as given in Table 21.6.

**TABLE 21.6**

**Minimum Length of Thread on Connections**

<table>
<thead>
<tr>
<th>Nominal size of meter</th>
<th>Minimum length of thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

Screws & studs shall be of brass or other corrosion resistant material.
21.3.16.12 **Strainers:**

Water meters shall be provided with strainers. Strainers shall be of a material which is not susceptible to electrolytic corrosion. They shall be of plastics or other corrosion-resistant materials for both Type A and Type B meters. They shall be rigid, easy to remove and clean, and shall be fitted on the inlet side of the water meter. It shall be possible to remove and clean the strainer in such a way as not to permit disturbing the registration box or tampering with it. The strainer shall have a total area of holes not less than twice the area of the nominal inlet bore of the pipe to which the meter is connected. However, in the case of meters provided with internal strainer involving opening of the registration box for cleaning, an additional external strainer shall be fitted on the inlet side satisfying the above requirements.

Overall dimension of water meters shall be as specified in Table 21.7

<table>
<thead>
<tr>
<th>Nominal size of Meter</th>
<th>Overall length including nipples (mm)</th>
<th>Overall width (Max.) (mm)</th>
<th>Overall height (Max.) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>250</td>
<td>100</td>
<td>180</td>
</tr>
<tr>
<td>20</td>
<td>290</td>
<td>130</td>
<td>240</td>
</tr>
<tr>
<td>25</td>
<td>380</td>
<td>170</td>
<td>260</td>
</tr>
<tr>
<td>40</td>
<td>430</td>
<td>210</td>
<td>300</td>
</tr>
<tr>
<td>50</td>
<td>470</td>
<td>270</td>
<td>300</td>
</tr>
</tbody>
</table>

Tolerance on the overall length shall be ± 5 mm for meter with nipples and +0, -2 mm for meters without nipples.

21.3.16.13 **Capacity on Short Period Rating or Nominal Capacity:**

The nominal capacity of the water meters shall be as specified in Table 21.8. The meters shall be capable of giving minimum discharges as stated in the table without the head loss exceeding 10 m within the meters.

<table>
<thead>
<tr>
<th>Nominal size of meter (mm)</th>
<th>Semi positive Type (liters)</th>
<th>Inferential Type (liters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2000</td>
<td>2500</td>
</tr>
<tr>
<td>20</td>
<td>3400</td>
<td>3500</td>
</tr>
<tr>
<td>25</td>
<td>5500</td>
<td>5500</td>
</tr>
<tr>
<td>40</td>
<td>10000</td>
<td>16000</td>
</tr>
<tr>
<td>50</td>
<td>15000</td>
<td>23000</td>
</tr>
</tbody>
</table>
21.3.17 Yarn (Spun)

Spun yarn shall be of clean hemp and of good quality. It shall be soaked in hot coal tar or bitumen and cooled before use.

21.4 LAYING AND JOINTING OF PIPES AND FITTINGS

21.4.1 Unloading

21.4.1.1 The pipes shall be unloaded where they are required.

21.4.1.2 Unloading (except where mechanical handling facilities are available): Pipes weighing up to 60 kg shall be handled by two persons by hand passing. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degree. The planks shall be sufficiently rigid and two ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

21.4.1.3 Under no circumstances shall the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

21.4.1.4 The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

21.4.2 Storing

21.4.2.1 The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench, socket facing upgrade when line runs uphill and upstream when line runs on level ground.

21.4.2.2 Each stack shall contain pipes of same class and size, consignment or batch number and particulars of suppliers, wherever possible, shall be marked on the stack.

21.4.2.3 Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

21.4.3 Cutting

21.4.3.1 Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.

21.4.3.2 A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe. The pipe shall be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters. The pipe shall be neatly cut at the chalk mark with carpenter’s saw or hacksaw having a long blade, by slowly
rotating the pipe around its longitudinal axis so as to have the uncut portion on
top for cutting. Cutting of the pipe at the overhang should, as far as possible,
be avoided, as an overhanging is liable to tear off due to its weight before the
cutting is complete.

21.4.4 Trenches
21.4.4.1 The Trenches shall be so dug that the pipes may be laid to the required
alignment and at required depth.
21.4.4.2 Cover shall be measured from top of pipe to the surface of the ground.
21.4.4.3 The bed of the trench, if in soft or made up earth, shall be well watered and
rammed before laying the pipes and the depressions, if any, shall be properly
filled with earth and consolidated in 20 cm layers.
21.4.4.4 If the trench bottom is extremely hard or rock or loose stony soil, the trench
shall be excavated at least 150 mm below the trench grade. Rocks, stone or
other hard substances from the bottom of the trench shall be removed and the
trench brought back to the required grade by filling with selected fine earth or
sand (or fine moorum if fine soil or sand is not available locally) and compacted
so as to provide a smooth bedding for the pipe. Where excavation requires
blasting operation, it shall be ensured that no pipes have been stacked in the
vicinity and completed pipe line in the vicinity has already been covered before
starting of blasting operations; this is necessary to prevent damage to the
exposed pipes in the vicinity by falling stones as a result of blasting.
21.4.4.5 After the excavation of the trench is completed, hollows shall be cut at the
required position to receive the socket of the pipes and these hollows shall be
of sufficient depth to ensure that the barrels of the pipes shall rest throughout
their entire length on the solid ground and that sufficient spaces left for jointing
the underside of the pipe joint. These socket holes shall be refilled with sand
after jointing the pipe.
21.4.4.6 Roots of trees within a distance of about 0.5 metre from the side of the pipe line
shall be removed or killed.
21.4.4.7 The excavated materials shall not be placed within 1 metre or half of the depth
of the trench, whichever is greater, from the edge of the trench. The materials
excavated shall be separated and stacked so that in refilling they may be re-
laid and compacted in the same order to the satisfaction of the Engineer-in-
Charge.
21.4.4.8 The trench shall be kept free from water. Shoring and timbering shall be
provided wherever required. Excavation below water table shall be done after
dewatering the trenches.
21.4.4.9 Where the pipe line or drain crosses an existing road, the road crossing shall
excavated half at a time, the 2nd half being commenced after the pipes have
been laid in the first half and the trench refilled. Necessary safety measures for
traffic as directed shall be adopted. All types, water mains cables, etc. met
within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-Charge.

21.4.5 Laying

21.4.5.1 The pipes shall be lowered into the trench by means of suitable pulley blocks, sheer legs chains ropes etc. In no case the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe, and pushed to the full distance that it can go. The pipe line shall be laid to the levels required. Specials shall also be laid in their proper position as stated above.

21.4.5.2 Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground, shall be laid with socket facing the direction of flow of water.

21.4.5.3 The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four metre long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to length of the collar plus 30 mm on both sides shall be provided at the joint which shall be refilled from sides after the joint is made.

21.4.5.4 In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipe lines and if required suitable special foundation shall be provided.

21.4.5.5 Some clayey soils (for examples black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry condition, these soils are subjected to extraordinary shrinkage which is usually seen in the form of wide and deep cracks in the earth surface and may result in damages to under ground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to excessive stresses as the clay shrinks. It is recommended that in such cases an envelope of a minimum 100 mm of tamped sand shall be made around the pipe line to avoid any bonding.

21.4.5.6 In places where rock is encountered, cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degree it may be necessary to anchor a few pipes against sliding downwards.

21.4.6 Thrust Blocks

21.4.6.0 Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting of pipe on to a larger load bearing soil section.
21.4.6.1 Thrust blocks shall be installed wherever there is a change in the direction/size of the pipe line or the pressure line diagram, or when the pipe line ends at a dead end. If necessary, thrust blocks may be constructed at valves also.

21.4.6.2 Thrust blocks shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity, component when laid on slopes and the type of soil.

21.4.6.3 When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

21.4.6.4 When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks of other means of anchoring. In such cases only pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

21.4.6.5 Pipes on slopes need be anchored only when there is a possibility of the back fill around the sloping down the hill and carrying the pipe with it. Generally for slopes up to 30 degree good well need soil carefully tamped in layers of 100 mm under and over the pipe, right upto the top of trench will not require anchoring.

21.4.6.6 For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

21.4.7 Back filling and Tamping

21.4.7.1 Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulders, eliminating possibility of lifting of the pipe due to flooding of open trench and shifting pipe out by caved in soil.

21.4.7.2 The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipe line. Tamping shall be done either by tamping bars or by using water to consolidate back fill materials.

21.4.7.3 The initial back fill material used shall be free of large stones and dry lumps. In stony areas the material for initial back fill can be shaved from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.

21.4.7.4 The initial back fill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.
21.4.7.5 If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed. Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.

21.4.7.6 Balance of the back fill need not be so carefully selected as the initial material. However, care shall be taken to avoid back filling with large stones which might damage the pipe when spaded into the trench.

21.4.7.7 Pipes in trenches on a slope shall have extra attention to make certain that the newly placed back fill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the back fill shall be tamped with extra care and the tamping continued in 100mm layers right up to the ground level.

21.4.8 Hydrostatic Tests

21.4.8.1 After a new pipe has been laid, jointed and back filled (or any valved section thereof), it shall be subjected to the following two tests:

(a) Pressure test at a pressure of at least double the maximum working pressure - pipe and joints shall be absolutely water tight under the test.

(b) Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for duration of two hours.

21.4.8.2 Hydrostatic Tests : The portions of the line shall be tested by subjecting to pressure test as the laying progresses before the entire line is completed. In this way any error of workmanship will be found immediately and can be corrected at a minimum cost. Usually the length of the section to be tested shall not exceed 500 m.

21.4.8.3 Where any section of a main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete is cast. If rapid hardening cement has been used in these blocks or anchorages, test shall not be made until at least two days have elapsed.

21.4.8.4 Prior to testing, enough back fill as described in 8.4.7 shall be placed over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

21.4.8.5 The open end of the section shall be sealed temporarily with an end cap having an outlet which can serve as an air relief vent or for filling the line, as may be required. The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate.

21.4.8.6 The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the pipe line before making the pressure strength testing because entrapped air gets
compressed and causes difficulty in raising the required pressure for the pressure strength test.

21.4.8.7 The test pressure shall be gradually raised at the rate of approximately one Kg/sq. cm/min. The duration of the test period if not specified shall be sufficient to make a careful check on the pipe line section.

21.5 LAYING AND JOINTING OF CAST IRON PIPES AND FITTINGS (EXTERNAL WORK)

21.5.0 Specification described in 21.4 shall apply, as far as applicable.

**TABLE 21.9**

<table>
<thead>
<tr>
<th>Class of Pipe</th>
<th>Maximum field test pressure kgf./sq.cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3.75</td>
</tr>
<tr>
<td>10</td>
<td>7.50</td>
</tr>
<tr>
<td>15</td>
<td>11.25</td>
</tr>
<tr>
<td>20</td>
<td>15.00</td>
</tr>
<tr>
<td>25</td>
<td>18.75</td>
</tr>
</tbody>
</table>

21.5.1 Trenches

21.5.1.1 The gradient is to be set out by means of boning rods and the required depth to be excavated at any point of the trench shall be regarded as directed by the Engineer-in-Charge. The depth of the trench shall not be less than 1 metre measured from the top of the pipe to the surface of the ground under roads and not less than 0.75 metre elsewhere.

21.5.1.2 The width of the trench shall be the nominal diameter of the pipe plus 40 cm but it shall not be less than 55cm in case of all kinds of soils excluding rock and not less than 1 metre in case of rock.

21.5.2 Laying

Any deviation either in plan or elevation less than 11.25 degrees shall be effected by laying the straight pipes around a flat curve of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 6mm or the opening between spigot and socket increased beyond 12mm at any joint. A deviation of about 2.25 degree can be effected at each joint in this way. At the end of each day’s work the last pipe laid shall have its open ends securely closed with a wooden plug to prevent entry of water, soil, rats and any other foreign matter into the pipe.

21.5.3 Lead Caulked Joints with Pig Lead

21.5.3.1 This type of lead caulking is generally done in providing joints in gas water and sewer lines wherever it is practicable to use lead caulking, but not in case of wet conditions.
21.5.3.2 The approximate depth and weights of pig lead for various diameters of C.I. pipes and specials shall be as given in Table 21.10.

**TABLE 21.10**
Lead for Different Sizes of pipes.

<table>
<thead>
<tr>
<th>Nominal size of Pipe mm</th>
<th>Lead per Joint Kg</th>
<th>Depth of lead joint mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>1.8</td>
<td>45</td>
</tr>
<tr>
<td>100</td>
<td>2.2</td>
<td>45</td>
</tr>
<tr>
<td>125</td>
<td>2.6</td>
<td>45</td>
</tr>
<tr>
<td>150</td>
<td>3.4</td>
<td>50</td>
</tr>
<tr>
<td>200</td>
<td>5.00</td>
<td>50</td>
</tr>
<tr>
<td>250</td>
<td>6.1</td>
<td>50</td>
</tr>
<tr>
<td>300</td>
<td>7.2</td>
<td>55</td>
</tr>
<tr>
<td>350</td>
<td>8.4</td>
<td>55</td>
</tr>
<tr>
<td>400</td>
<td>9.5</td>
<td>55</td>
</tr>
<tr>
<td>450</td>
<td>14.0</td>
<td>55</td>
</tr>
<tr>
<td>500</td>
<td>15.0</td>
<td>60</td>
</tr>
<tr>
<td>600</td>
<td>19.0</td>
<td>60</td>
</tr>
<tr>
<td>700</td>
<td>22.00</td>
<td>60</td>
</tr>
<tr>
<td>750</td>
<td>25.00</td>
<td>60</td>
</tr>
</tbody>
</table>

Note:

1. The quantity of lead given in the table is on average basis and a variation of 10 per cent is permissible.

2. Before pipes are jointed on large scale, three or four sample joints shall be made and the average consumption of lead per joint shall be got approved by the Engineer-in-Charge.

   Only required quantity of spun yarn shall be put so as to give the specified depth of lead in the joint.

21.5.4 Lead Caulked Joint with Lead Wool Yarn

21.5.4.1 This type of Lead caulking is generally done when it is inconvenient or dangerous to use molten lead for joints, for example in cases such as inverted joints or in wet trenches or in exceptional cases. In such cases the joints shall be made with lead wool or yarn. Caulking with lead wool or yarn shall however be not carried out without the prior permission of Engineer-in-Charge.

21.5.4.2 The approximate weights and depths of lead wool or lead yarn required for each joint of various dia of C.I. pipes and specials shall be as given in Table 21.11. Just sufficient quantity of spun yarn shall be put so as to give specified depth of lead wool.
21.5.4.3 Jointing: The spun yarn shall first be inserted and caulked into the socket as described under jointing with pig lead. Lead wool or yarn shall then be introduced in the joint in strings not less than 6mm thick and the caulking shall be repeated with each turn of lead wool or yarn. The whole of the lead wool or yarn shall be compressed into a dense mass. The joint shall then be finally finished flush with face of the socket.

21.5.5 Flanged Joints

21.5.5.1 Cast iron pipes may be jointed by means of flanges cast on. The jointing material used between flanges of pipes shall be compressed fiber board or rubber of thickness between 1.5 mm to 3 mm. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per m² shall be not less than 112 gm/mm thickness.

**TABLE 21.11**

<table>
<thead>
<tr>
<th>Diameter of pipe (mm)</th>
<th>Weight of lead wool or lead yarn (kg)</th>
<th>Depth of lead wool or lead yarn (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0.80</td>
<td>19</td>
</tr>
<tr>
<td>100</td>
<td>0.90</td>
<td>19</td>
</tr>
<tr>
<td>125</td>
<td>1.25</td>
<td>20</td>
</tr>
<tr>
<td>150</td>
<td>1.60</td>
<td>23</td>
</tr>
<tr>
<td>200</td>
<td>2.05</td>
<td>23</td>
</tr>
<tr>
<td>250</td>
<td>2.95</td>
<td>25</td>
</tr>
<tr>
<td>300</td>
<td>3.50</td>
<td>25</td>
</tr>
<tr>
<td>350</td>
<td>4.65</td>
<td>29</td>
</tr>
<tr>
<td>400</td>
<td>5.70</td>
<td>31</td>
</tr>
<tr>
<td>450</td>
<td>6.70</td>
<td>32</td>
</tr>
<tr>
<td>500</td>
<td>8.30</td>
<td>33</td>
</tr>
<tr>
<td>600</td>
<td>10.00</td>
<td>35</td>
</tr>
<tr>
<td>700</td>
<td>11.80</td>
<td>36</td>
</tr>
<tr>
<td>750</td>
<td>13.60</td>
<td>38</td>
</tr>
<tr>
<td>800</td>
<td>15.40</td>
<td>40</td>
</tr>
<tr>
<td>900</td>
<td>16.80</td>
<td>40</td>
</tr>
</tbody>
</table>

**Note:** An allowance of five per cent variation in the specified weights and depths is permissible.

21.5.5.2 Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another shall not be allowed.

21.5.5.3 Several proprietary flexible joints are available for jointing cast iron pipes and these may be used with the specific approval of the authority, however, they shall be used strictly in accordance with the manufacture’s instructions.
21.5.5.4 For joints in small diameter cast iron piping, copper-alloy screwed unions or ferruls shall be used, and for large dia. The joints shall be made by flanged connecting pieces.

21.5.6 Hydrostatic

The procedure for testing for leakage under pressure shall be as described in Appendix D of Chapter 8 which is to be read in addition to 8.4.8. The joints of pipes and specials have to be repaired till the leakage in the portion under test is within the specified limit indicated in Appendix-D.

21.5.7 Measurements

21.5.7.1 The net length of pipes as laid or fixed, shall be measured in the running metres correct to a cm. specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

21.5.7.2 Excavation, refilling, shoring and timbering in trenches masonry or concrete pillars and thrust blocks, wherever required, shall be measured and paid for separately, under relevant items of work.

21.5.7.3 Lead caulked joins shall be measured and paid for separately.

21.5.8 Rate

The rate shall include the cost of materials and labour involved in all the operations described above except for the items measured/enumerated separately under Para 21.4.7.1, 21.4.7.2, 21.4.7.3 which shall be paid for separately.

21.6 LAYING AND JOINTING OF G.I. PIPES (EXTERNAL WORK)

21.6.0 The specifications described in 18.4 shall apply, as far as applicable.

21.6.1 Trenches

The galvanized iron pipes and fitting shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in Table 21.12.

<table>
<thead>
<tr>
<th>Dia of pipe (mm)</th>
<th>Width of trench (cm)</th>
<th>Depth of trench (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 to 50</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>65 to 100</td>
<td>45</td>
<td>75</td>
</tr>
</tbody>
</table>

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.
21.6.2 Cutting and Threading

Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS 554 with pipe dies and taps in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bend or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of pipes and fitting shall be protected from damage until they are fitted.

21.6.3 Jointing

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over. Teflon Tape should be used on threads instead of ‘Dhaaga/Safeda’. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

21.6.4 Thrust Blocks

blocks of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20mm nominal size) of adequate size and shape shall be provided on all bends to transmit the hydraulic thrust to the ground, spreading it over a sufficient areas, depending upon the type of soil met with.

21.6.5 Painting

The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

21.6.6 Testing of Joints

The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 6 Kg/ sq. cm (60 meter). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. Pipes or fitting which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

21.6.7 Trench Filling

The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed off as directed.
21.6.8 Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipes and G.I. fittings such as bends, tees, elbows reducers, crosses, plugs, sockets, nipple and nuts but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured.

G.I. unions shall be paid for separately in external work as well as in internal work.

Digging and refilling of trenches shall either be measured separately as specified in the appropriate clauses of excavation and earth work or clubbed with main item.

21.6.9 Rate

The rate shall include the cost of labour and materials involved in all the operations described above. The rate shall not include excavation in trenches, painting of pipes and sand filling all round the pipes unless otherwise specified.

21.7 LAYING AND JOINTING G.I. PIPES (INTERNAL WORK)

21.7.0 For internal work the galvanized iron pipes and fittings shall run on the surface of the walls on ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer-in-Charge, as M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall be not come in contact with lime mortar or lime concrete as the pipes is affected by lime. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly or the pipes when tightened with screwed bolts, these clamps shall be embedded in brick work in cement mortar 1:3 (1 cement : 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in Table 21.13.

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer-in-Charge.
For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes holes shall be carefully made of the smallest size as directed by the Engineer-in-Charge. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) and properly finished to match the adjacent surface.

**TABLE 21.13**

<table>
<thead>
<tr>
<th>Dia. Of Pipe (mm)</th>
<th>Horizontal length M</th>
<th>Vertical length M</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>20</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>25</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>2.5</td>
<td>3</td>
</tr>
<tr>
<td>40</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>50</td>
<td>3</td>
<td>3.5</td>
</tr>
<tr>
<td>65</td>
<td>3.5</td>
<td>5</td>
</tr>
<tr>
<td>80</td>
<td>3.5</td>
<td>5</td>
</tr>
</tbody>
</table>

Unions will be provided to facilitate connections additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the Engineer-in-Charge.

21.7.1 Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) and pipes fixed to walls, ceilings, etc. with supports shall be measured separately.

21.7.2 Rate

The rate shall include the cost of labour and material involved in all the operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. This shall not however, include concealed pipe work in which case cutting of chase and making good shall be paid separately. It shall not include painting of pipes and providing sleeves, unless specified otherwise. It will also not include union which shall be paid for separately.

21.8 POLYPROPYLENE RANDOM CO-POLYMER (PP-R) PIPES

21.1 The PP-R is a bonded, multilayer pipe consisting of different layers of the pipe:-
(a) The inner-most layer of the pipe to be Anti – bacterial to prevent bacteria growth inside pipe surface.

(b) The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct effect of the atmospheric conditions.

(c) The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight under exposed atmospheric conditions.

The pipes should in general be conforming to the requirements of IS 15801 except that specified with in nomenclature of the item. The pipes should have smooth inner surface with non-contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects. The pipes shall be clean and well cut along ends after taking into consideration the desired length, using the pipe scissors. The Polypropylene used for manufacturing the pipe shall conform to the requirements of IS 10951 and IS 10910. The specified base density shall be between 900 kg/m$^3$ and 910 kg/m$^3$ when determined at 27$^0$C. The resin should be mixed with sufficient quantity of colour master batches. The colour master batch should be uniform throughout the pipe surface. The standard dimension ratio (SDR) i.e. ratio of the nominal outer diameter of a pipe to its nominal wall thickness should be 7.4/11 as given in the item.

21.8.2 Fittings

Plan fittings, Chrome plated brass threaded fittings and Valves shall be as per nomenclature of item or as directed by engineer-in-charge.

(a) The plain fittings shall be Polypropylene Random Copolymer and comply with all the requirements of the pipes. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded Plug and wall clamps in available sizes.

(b) The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass thread piece molded inside Polypropylene random copolymer fitting. The material shall comply with all the requirements of the pipes. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C.P. connections and for continuations from existing Galvanized iron Pipes and fittings.

(c) The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate valve, Ball Valve, concealed stop valve and Chrome coated Valve in available sizes.

The Valves sizes availability in Polypropylene Random Copolymer is as follows:-

(i) Gate Valve - 20mm to 63mm
(ii) Ball Valve -20mm,25mm,32mm,40mm,50mm & 63mm
(iii) Concealed Stop valve - 20mm & 25mm
(iv) Chrome Coated Valve - 20mm & 25mm
However, the other Brass/Bronze Valves can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes.

21.8.3 Laying and Jointing of Pipes and Fittings

The specifications described in 21.4 shall apply as far as possible. The pipes and fittings shall run in wall chase as specified. Pipes shall run only in vertical or horizontal alignment as far as possible. The installation of pipes is similar to that of the metal pipes with the only difference in the jointing procedure. The jointing of the PP-R pipes and fittings are done by fusion welding by means of a welding machine. The marking on pipe shall carry the following information:

- (c) Manufacturer’s name/trade mark
- (d) PPR pipe
- (e) SDR
- (f) Outside diameter and minimum wall thickness
- (g) Lot No./Batch No. containing date of manufacturing. And machine number.

21.8.4 The outside diameter of pipes, tolerance in the same and ovality of pipe shall be as given in Table 21.14 below

**TABLE 21.14**

Outside, Diameter, Tolerance and Ovality of Pipes

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal Size</th>
<th>Outside Diameter</th>
<th>Tolerance (Only positive tolerance)</th>
<th>Ovality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DN</td>
<td>Mm</td>
<td>Mm</td>
<td>mm</td>
</tr>
<tr>
<td>(1)</td>
<td>16</td>
<td>16.0</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>(i)</td>
<td>20</td>
<td>20.0</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>(ii)</td>
<td>25</td>
<td>25.0</td>
<td>0.3</td>
<td>1.2</td>
</tr>
<tr>
<td>(iii)</td>
<td>32</td>
<td>32.0</td>
<td>0.3</td>
<td>1.3</td>
</tr>
<tr>
<td>(iv)</td>
<td>40</td>
<td>40.0</td>
<td>0.4</td>
<td>1.4</td>
</tr>
<tr>
<td>(v)</td>
<td>50</td>
<td>50.0</td>
<td>0.5</td>
<td>1.4</td>
</tr>
<tr>
<td>(vi)</td>
<td>63</td>
<td>63.0</td>
<td>0.6</td>
<td>1.6</td>
</tr>
<tr>
<td>(vii)</td>
<td>75</td>
<td>75.0</td>
<td>0.7</td>
<td>1.6</td>
</tr>
<tr>
<td>(viii)</td>
<td>90</td>
<td>90.0</td>
<td>0.9</td>
<td>1.8</td>
</tr>
<tr>
<td>(ix)</td>
<td>110</td>
<td>110.0</td>
<td>0.9</td>
<td>2.2</td>
</tr>
</tbody>
</table>

1. The values specified for tolerance on outside diameter have been calculated as 0.009DN, rounded off to the next higher 0.1mm subject to minimum of 0.3 mm. No. negative tolerances are allowed.

2. The basis for the values specified for ovality is:
(a) For nominal outside diameters ≥ 75 mm, the tolerance equals (0.008 DN + 1.0) mm, rounded to the next higher 0.1 mm, with a minimum value of 1.2 mm.

(b) For nominal outside diameters ≥ 75 mm and ≤ 250 mm, the tolerance equals 0.20 DN, rounded to the next higher 0.1 mm.

(c) For nominal outside diameter ≥ 250 mm, the tolerance equals 0.35 DN, rounded to the next higher 0.1 mm.

21.8.5 Wall Thickness

The minimum and maximum wall thickness of pipes shall be as given in Table 21.15:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal Size</th>
<th>SDR 11</th>
<th>SDR 7.4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DN</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(i)</td>
<td>16</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(ii)</td>
<td>20</td>
<td>1.90</td>
<td>2.30</td>
</tr>
<tr>
<td>(iii)</td>
<td>25</td>
<td>2.30</td>
<td>2.80</td>
</tr>
<tr>
<td>(iv)</td>
<td>32</td>
<td>2.90</td>
<td>3.40</td>
</tr>
<tr>
<td>(v)</td>
<td>40</td>
<td>3.70</td>
<td>4.30</td>
</tr>
<tr>
<td>(vi)</td>
<td>50</td>
<td>4.60</td>
<td>5.30</td>
</tr>
<tr>
<td>(vii)</td>
<td>63</td>
<td>5.80</td>
<td>6.60</td>
</tr>
<tr>
<td>(viii)</td>
<td>75</td>
<td>6.80</td>
<td>7.70</td>
</tr>
<tr>
<td>(ix)</td>
<td>90</td>
<td>8.20</td>
<td>9.30</td>
</tr>
<tr>
<td>(x)</td>
<td>110</td>
<td>10.00</td>
<td>11.20</td>
</tr>
</tbody>
</table>

Note: The wall thickness tolerance have been calculated on the following basis:

(a) Limit deviation = 0.1e + 0.2 mm rounded up to the nearest 0.1 mm.

(b) A local increase in wall thickness of up to 0.2e is permissible for e up to 10 mm and up to 0.15e for e greater than 10 mm. The mean of the measurement shall, however, still lie within the given limit deviations.

The quality of each installation system ultimately depends on the tightness, stability, and lifetime of its connections. The pipe of the desired length is cut using the pipe scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on – Control lamp and switch lamp will light. When ready, control lamp gets off, which means that welding temperature of 260 Degrees ± 10 Degrees Celsius has been reached. The pipe end and the fitting to be welded are heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting are cleaned with a cloth. When heated up (with heating time as per the Table shown below), the pipe and the fitting is removed from the welding machine and the two pieces connected together by applying a little pressure without
twisting. The joint is allowed to cool down for a few seconds. The welding process is that safe because the properly heated part of polypropylene create a homogeneous connection.

Guideline for Welding PP-R Pipes and Fittings (DVS Guideline 2207, Part II)

Table 21.16

<table>
<thead>
<tr>
<th>Outer diameter of pipe (mm)</th>
<th>Heating Time (Seconds)</th>
<th>Cooling Period (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>25</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>32</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>40</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>50</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>63</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>75</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>90</td>
<td>30</td>
<td>8</td>
</tr>
</tbody>
</table>

The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers may be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps keeping the pipes about 1.5cm clear of the wall where to be laid on the surfaces. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not but installed at bending parts and the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length. For exposed straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.

21.8.6 Piping Installation Support

Piping shall be properly supported by means of wall support clamps as specified and as required, keeping in view the proper designing for expansion and contraction. Risers shall be supported at each floor with clamps. Due to high coefficient of thermal expansion the heat losses though the pipes is highly reduced. Therefore, for internal Bathroom hot geyser water distribution lines, the insulation is often not required.

21.8.7 Installation of Water Meter and Valves
PP-R lines shall be cut to the required lengths at the position where the meter and Valves are required to be fixed. Suitable C.P. Brass threaded fittings shall be attached to the pipes. The meter and valves shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter shall be installed exactly horizontally or vertically in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken to not to disturb the factory seal of the meter. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter.

21.8.8 Testing

All water supply system shall be tested to Hydrostatic pressure test. Maximum operating pressure at varying degree of temperature is given in Table 21.17:

### Table 21.17

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Temperature</th>
<th>SDR 11 Pressure MPa</th>
<th>SDR 7.4 Pressure MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>10</td>
<td>1.91</td>
<td>3.02</td>
</tr>
<tr>
<td>(ii)</td>
<td>20</td>
<td>1.63</td>
<td>2.58</td>
</tr>
<tr>
<td>(iii)</td>
<td>30</td>
<td>1.37</td>
<td>2.17</td>
</tr>
<tr>
<td>(iv)</td>
<td>40</td>
<td>1.15</td>
<td>1.84</td>
</tr>
<tr>
<td>(v)</td>
<td>50</td>
<td>0.98</td>
<td>1.55</td>
</tr>
<tr>
<td>(vi)</td>
<td>60</td>
<td>0.82</td>
<td>1.28</td>
</tr>
<tr>
<td>(vii)</td>
<td>70</td>
<td>0.62</td>
<td>0.98</td>
</tr>
<tr>
<td>(viii)</td>
<td>80</td>
<td>0.39</td>
<td>0.62</td>
</tr>
<tr>
<td>(ix)</td>
<td>95</td>
<td>0.27</td>
<td>0.4</td>
</tr>
</tbody>
</table>

The pressure test is performed in 3 steps being preliminary test, main test and final test. For the preliminary test a pressure which is 1.5 times higher than the possible working pressure is applied and this is repeated two time in 30 minutes with intervals of 10 minutes. After a test period of 30 minutes, the test pressure must not be dropped more than 0.6 bar and no leak must occur. Main test follows the preliminary test. Test time is two hours, in doing so the test pressure taken from the preliminary test must not have fallen more than 0.2 bar. After completion of these tests, the final test comes which has to be done under a test pressure of 10 bars and 5 bar in the interval of 15 minutes. Between the respective test courses, pressure has to be removed.
All leaks and defects in joints revealed during the testing shall be rectified and
got approved at site by retest. Piping required subsequent to the above
pressure test shall be retested in the same manner.

System may be tested in sections and such section shall be entirely checked
on completion of connection to the overhead tanks or pumping system or
mains. In case of improper circulation, the contractor shall rectify the defective
connections. He shall bear all expenses for carrying out the above rectifications
including the tearing up and refinishing of floors and walls as required.

After commissioning of the water supply system, contractor shall test each
valve by closing and opening it a number of times to observe if it is working
efficiently. Valves which are not working efficiently shall be replaced by new
ones.

21.8.9 Measurements

The net length of pipes as laid or fixed shall be measured in running meters
correct to a cm for the finished work, which shall include PP-R pipe and fittings
including plain fittings and Chrome Plated Brass Threaded fittings. Deductions
for the length of valves shall be made. The cost includes cutting chases in the
masonry wall and making good the same, trenching, refilling and testing of
joints. The cost of gate valves/wheel valves/union shall be paid for separately.

21.9 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPES

21.9.1 CPVC pipes & fittings used in hot & cold potable water distribution system shall
conform to requirement of IS 15778. The material from which
the pipe is
produced shall consist of chlorinated polyvinyl chlorides. The polymer from
which the pipe compounds are to be manufactured shall have chlorine content
not less than 66.5%.

The internal and external surfaces of the pipe shall be smooth, clean and free
from grooving and other defects. The pipes shall not have any detrimental
effect on the composition of the water flowing though it.

Diameter and wall thickness of CPVC pipes are as per given in Table 21.18.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal size</th>
<th>Nominal Outside Diameter</th>
<th>Mean Outside Diameter</th>
<th>Outside Diameter at any point</th>
<th>Wall thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>1</td>
<td>(i)</td>
<td>15</td>
<td>15.9</td>
<td>15.8</td>
<td>15.8</td>
</tr>
<tr>
<td>(ii)</td>
<td>20</td>
<td>22.2</td>
<td>22.1</td>
<td>22.3</td>
<td>22.0</td>
</tr>
<tr>
<td>(iii)</td>
<td>25</td>
<td>28.6</td>
<td>28.5</td>
<td>28.7</td>
<td>28.4</td>
</tr>
<tr>
<td>(iv)</td>
<td>32</td>
<td>34.9</td>
<td>34.8</td>
<td>35.0</td>
<td>34.7</td>
</tr>
<tr>
<td>(v)</td>
<td>40</td>
<td>41.3</td>
<td>41.2</td>
<td>41.4</td>
<td>41.1</td>
</tr>
<tr>
<td>(vi)</td>
<td>50</td>
<td>54.0</td>
<td>53.9</td>
<td>54.1</td>
<td>53.7</td>
</tr>
<tr>
<td>S.No.</td>
<td>Nominal Size</td>
<td>Nominal Outside Diameter</td>
<td>Mean Outside Diameter</td>
<td>Outside Diameter at any point</td>
<td>Wall thickness</td>
</tr>
<tr>
<td>-------</td>
<td>--------------</td>
<td>--------------------------</td>
<td>-----------------------</td>
<td>-----------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>1</td>
<td>(vii)</td>
<td>65</td>
<td>73.0</td>
<td>72.8</td>
<td>73.2</td>
</tr>
<tr>
<td>2</td>
<td>(viii)</td>
<td>80</td>
<td>88.9</td>
<td>88.7</td>
<td>89.1</td>
</tr>
<tr>
<td>3</td>
<td>(ix)</td>
<td>100</td>
<td>114.3</td>
<td>114.1</td>
<td>114.5</td>
</tr>
<tr>
<td>4</td>
<td>(x)</td>
<td>150</td>
<td>168.3</td>
<td>168.0</td>
<td>168.6</td>
</tr>
</tbody>
</table>

Notes:-

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

21.9.2 Dimensions of Pipes

The outside diameter, outside diameter at any point and wall thickness shall be as given in Table 21.18.

21.9.2.1 Diameter : The outside diameter and outside diameter at any point as given in Table 21.18 shall be measured according to the method given in IS 12235 (part 1).

21.9.2.2 Diameter at any point : The difference between the measured maximum outside diameter and measured minimum outside diameter in the same cross-section of pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

(a) 0.5mm, and
(b) 0.012dn rounded off to the next higher 0.1 mm.

21.9.2.3 Wall Thickness: The wall thickness of the pipes shall be as given in Table 21.18. Wall thickness shall be measured by any of the three methods given in IS 12235 (part 1). To check the conformity of the wall thickness of the pipe throughout its entire length, it is necessary to measure the wall thickness of the pipe at any point along its length. This shall be done by cutting the pipe at any point along its length and measuring the wall thickness as above. Alternatively, to avoid destruction of the pipe, non destructive testing methods such as the use of ultrasonic wall thickness measurement gauges shall be used at any four points along the length of the pipe.

Tolerance on wall Thickness

(a) For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness \( e_{\text{Min}} \) and the wall thickness at any point \( e \), \( (e-e_{\text{Min}}) \) shall be positive in the form of \( +y \), where \( y = 0.1 \ e_{\text{Min}} + 0.2 \text{mm} \).
For pipes of minimum wall thickness greater than 6 mm, the permissible variation of wall thickness shall again be positive in the form of $+y$, where $y$ would be applied in two parts.

The average wall thickness shall be determined by taking at least six measurement of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values. The tolerance applied to this average wall thickness from these measurements shall be within the range $0.1 \, \text{e}_{\text{Min}} + 0.2\text{mm}$ (see Table 21.18).

The maximum wall thickness at any point shall be within the range $0.15 \, \text{e}_{\text{Min}}$ (see Table 21.18).

The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.

21.9.2.4 Effective Length ($L_e$): If the length of a pipe is specified, the effective length shall not be less than that specified. The preferred effective length of pipes shall be 3, 5 or 6 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.

21.9.3 Pipe Ends

The ends of the pipes meant for solvent cementing shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain end.

21.9.4 Physical and Chemical Characteristics

21.9.4.1 Visual Appearance: The colour of the pipes shall be off-white. Slight variations in the appearance of the colour are permitted.

The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects.

21.9.4.2 Opacity: The wall of the plain pipe shall not transmit more than 0.1 per cent of the visible light falling on it when tested in accordance with IS 12235 (Part 3).

21.9.4.3 Effect on Water: The pipes shall not have any determinate effect on the composition of the water flowing through them, when tested as per 10.3 of IS 4985.

21.9.4.4 Reversion Test: When tested by the method prescribed in IS 12235 (Part 5/Sec 1 and Sec 2), length of pipe 200 $\pm$ 20mm long shall not alter in length by more than 5 per cent.

21.9.4.5 Vicat Softening Temperature: When tested by the method prescribed in IS 12235 (part 2), the Vicat softening temperature of the specimen shall not be less than 110°C.
21.9.4.6 Density: When tested in accordance with IS 12235 (Part 14), the density of the pipes shall be between 1450kg/m³ and 1650Kg/m³.

21.9.5 Mechanical Properties

21.9.5.1 Hydrostatic Characteristics: When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (part 8/Sec 1), the pipe shall not fail during the prescribed test duration. The temperatures, duration and hydrostatic (hoop) stress for the test shall conform to the requirements given in Table 21.19. The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

### TABLE 21.19
Requirements of Pipes for Internal Hydrostatic Pressure Test

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Test</th>
<th>Test Temperature Min</th>
<th>Test Period</th>
<th>Hydrostatic (Hoop) Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>°C</td>
<td>h</td>
<td>MPa</td>
</tr>
<tr>
<td>1</td>
<td>(i) Acceptance</td>
<td>20</td>
<td>1</td>
<td>43.0</td>
</tr>
<tr>
<td>(ii)</td>
<td>Type</td>
<td>95</td>
<td>165</td>
<td>5.6</td>
</tr>
<tr>
<td>(iii)</td>
<td>Type</td>
<td>95</td>
<td>1000</td>
<td>4.6</td>
</tr>
<tr>
<td>(iv)</td>
<td>Type</td>
<td>95</td>
<td>8760</td>
<td>3.6 (Test for thermal stability)</td>
</tr>
</tbody>
</table>

21.9.5.2 Thermal Stability by Hydrostatic Pressure Testing:

When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8/Sec 1) and as per requirement given in Table 21.19, Sl. No. (iv), the pipe shall not burst or leak during the prescribed test duration.

21.9.5.3 Resistance to External Blow at 0°C:

When tested by the method prescribed in IS 4985, with classified striker mass and drop height as given in Table 21.20, the pipe shall have a true impact rate of not more than 10 per cent.

### TABLE 21.20
Classified Striker Mass and Drop Height Conditions for the Falling Weight Impact Test

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal Pipe Size</th>
<th>Mass of Falling Weight</th>
<th>Falling Height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mm</td>
<td>Kg</td>
<td>Mm</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>15</td>
<td>0.5±0.5%</td>
<td>300±10</td>
</tr>
<tr>
<td>(ii)</td>
<td>20</td>
<td>0.5±0.5%</td>
<td>400±10</td>
</tr>
<tr>
<td>(iii)</td>
<td>25</td>
<td>0.5±0.5%</td>
<td>500±10</td>
</tr>
<tr>
<td>(iv)</td>
<td>32</td>
<td>0.5±0.5%</td>
<td>600±10</td>
</tr>
<tr>
<td>(v)</td>
<td>40</td>
<td>0.5±0.5%</td>
<td>800±10</td>
</tr>
<tr>
<td>S.No.</td>
<td>Nominal Pipe Size</td>
<td>Mass of Falling Weight</td>
<td>Falling Height</td>
</tr>
<tr>
<td>-------</td>
<td>------------------</td>
<td>------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>(vi)</td>
<td>50</td>
<td>0.5±0.5%</td>
<td>1000±10</td>
</tr>
<tr>
<td>(vii)</td>
<td>65</td>
<td>0.8±0.5%</td>
<td>1000±10</td>
</tr>
<tr>
<td>(viii)</td>
<td>80</td>
<td>0.8±0.5%</td>
<td>1200±10</td>
</tr>
<tr>
<td>(ix)</td>
<td>100</td>
<td>1.0±0.5%</td>
<td>1600±10</td>
</tr>
<tr>
<td>(x)</td>
<td>150</td>
<td>1.6±0.5%</td>
<td>2000±10</td>
</tr>
</tbody>
</table>

21.9.5.4 **Flattening Test:**
When tested by the method prescribed in IS 12235 (part 19), pipe shall show no signs of cracking, splitting and breaking.

21.9.5.5 **Tensile Strength:**
When tested by the method prescribed in IS 12235 (Part 19), the tensile strength at yield shall not be less than 50 MPa at 27 ± 2°C.

21.9.6 **Sampling and Criteria for Conformity**
The sampling procedure and criteria for conformity shall be as given in Annexure F.

21.9.7 **Marking**
21.9.7.1 Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 m. The marking shall show the following:

   (a) Manufacture’s name or trade-mark.
   (b) Outside diameter
   (c) Class of pipe and pressure rating, and
   (d) Bath or lot number

21.9.7.2 **BIS Certification Marking:** Each pipe may also be marked with the Standard Mark.

21.9.8 **Fittings**
The fittings shall be as follows:

   (a) Plain CPVC solvent cement fittings from size 15mm to 160mm.
   (b) Brass threaded fittings
   (c) Valve from size 15mm to 160mm
   (d) Brass Threaded Fittings: All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings. Ball, Gate valves in CPVC are available in all dimensions. All fittings shall carry the following information:

      (1) Manufacturer’s name/trade mark.
      (2) Size of fitting

21.9.9 **Piping Installation Support and Spacing**
21.9.9.1 Concealed Piping: Pipes can be concealed in chases. The pipes and fitting are to be pressure tested prior to concealing the chases. To maintain alignment of CP fittings while joining, all alignment of fittings and pipe shall be done correctly. DO NOT USE NAILS FOR HOLDING OF PIPES IN THE CHASES.

21.9.9.2 External Installations: For pipes fixed in the shafts, ducts etc. there should be sufficient space of work on the pipes. Pipes sleeves shall be fixed at a place the pipe is passing through a wall or floor so as to allow freedom for expansion and contraction. Clamping of the pipe is done to support it while allowing the freedom for movement.

All pipes exposed to sunlight shall be painted with a water based acrylic paint emulsion to enhance UV protection. Pipes in trenching shall be laid in accordance to the Good Plumbing practices followed for Metal piping.

**Recommended Support Spacing (Distance between Pipe Clamps Horizontal Support)**

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Horizontal Support (In meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Temperature</td>
</tr>
<tr>
<td></td>
<td>23°C</td>
</tr>
<tr>
<td>16 mm (1/2&quot;)</td>
<td>1.22</td>
</tr>
<tr>
<td>20 mm (3/4&quot;)</td>
<td>1.53</td>
</tr>
<tr>
<td>25 mm (1&quot;)</td>
<td>1.68</td>
</tr>
<tr>
<td>32 mm (1 ¼&quot;)</td>
<td>1.83</td>
</tr>
<tr>
<td>40 mm (1 ½&quot;)</td>
<td>1.98</td>
</tr>
<tr>
<td>50 mm (2&quot;)</td>
<td>2.29</td>
</tr>
</tbody>
</table>

21.9.9.3 Expansion Loop: CPVC systems, like all piping materials, expand and contract with changes in temperatures. CPVC pipes shall expand 7.5 cm per 30 m length for a 40°C temperature change.

Expansion does not vary with Pipe size. Thermal expansion can be generally be accommodated a changes in direction. On a long straight run, an offset or loop based on the following chart is required.

**Table 21.22**

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Length of Run (Meter), Loop length in cms.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 metre</td>
</tr>
<tr>
<td>15mm</td>
<td>43</td>
</tr>
<tr>
<td>20mm</td>
<td>48</td>
</tr>
<tr>
<td>25mm</td>
<td>53</td>
</tr>
<tr>
<td>32mm</td>
<td>58</td>
</tr>
<tr>
<td>40mm</td>
<td>63</td>
</tr>
<tr>
<td>50mm</td>
<td>71</td>
</tr>
</tbody>
</table>

21.9.10 Testing
All water supply systems shall be tested to hydrostatic pressure test. The pressure tests are similar to the test pressure used for other plastic/metal pipes. System may be tested in sections and such section shall be entirely checked on completion of connection to the overhead tank or pumping system or mains.

21.9.11 Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include CPVC pipe and fittings including plain and Brass threaded fittings and jointing solvent cement.

21.10 PE-AL-PE PIPES

21.10.1 The PE-AL-PE pipes are bonded, multilayer pipes consisting of metal aluminum and polyethylene i.e. metallic pipe bonded with adhesive both internally and externally by polyethylene coating. The layers of PE-AL-PE pipes are:

(i) The interior layer of polyethylene
(ii) The adhesive layer
(iii) Aluminium tube
(iv) The adhesive layer
(v) The external layer of polyethylene

Polyethylene composite pressure pipes have welded aluminium tube reinforcement between inner and outer polyethylene layers, inner and outer polyethylene layer being bonded to aluminium tube by melt adhesive and are manufactured as per IS 15450.

The specially manufactured compression joints fittings should be used for PE-AL-PE pipes which are available in 3 types i.e. brass, composite and composite external sealing. Either of these fittings should be used. The external sealing fittings should be used only for cold water applications.

21.10.2 (i) Polyethylene compounds shall conform to IS 7328 as follows:

(a) PEEWA 45 T006 for black pipes and
(b) PEELA 45 T006 for coloured pipes.

(ii) Aluminium shall have following properties:

(a) Minimum elongation : 20%
(b) Ultimate tensile strength: 100 MPa

The aluminium strip shall have nominal thickness as specified in Table 21.23 (i). Tolerances on all thickness for all sizes shall be (+) 0.02 mm.
TABLE 21.23 (I)
Aluminium Thickness and Tolerances for PE-AL-PE Pipe

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Nominal Pipe Size (mm)</th>
<th>Nominal Aluminium Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>1216</td>
<td>0.20</td>
</tr>
<tr>
<td>(ii)</td>
<td>1620</td>
<td>0.25</td>
</tr>
<tr>
<td>(iii)</td>
<td>2025</td>
<td>0.25</td>
</tr>
<tr>
<td>(iv)</td>
<td>2532</td>
<td>0.30</td>
</tr>
<tr>
<td>(v)</td>
<td>3240</td>
<td>0.30</td>
</tr>
<tr>
<td>(vi)</td>
<td>4050</td>
<td>0.30</td>
</tr>
</tbody>
</table>

(iii) Dimensions of pipes shall be as given in Table 21.23 (ii)

TABLE 21.23 (II)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Nominal Pipe size (mm)</th>
<th>Nominal outside diameter (OD) mm</th>
<th>Total wall thickness Minimum mm</th>
<th>Maximum (mm)</th>
<th>Outer PE layer thickness Minimum (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>1216</td>
<td>16</td>
<td>1.75</td>
<td>2.00</td>
<td>0.40</td>
</tr>
<tr>
<td>(ii)</td>
<td>1620</td>
<td>20</td>
<td>2.00</td>
<td>2.25</td>
<td>0.40</td>
</tr>
<tr>
<td>(iii)</td>
<td>2025</td>
<td>25</td>
<td>2.45</td>
<td>2.70</td>
<td>0.40</td>
</tr>
<tr>
<td>(iv)</td>
<td>2532</td>
<td>32</td>
<td>2.80</td>
<td>3.20</td>
<td>0.40</td>
</tr>
<tr>
<td>(v)</td>
<td>3240</td>
<td>40</td>
<td>3.40</td>
<td>3.80</td>
<td>0.40</td>
</tr>
<tr>
<td>(vi)</td>
<td>4050</td>
<td>50</td>
<td>4.00</td>
<td>4.40</td>
<td>0.40</td>
</tr>
</tbody>
</table>

(iv) The PE-AL-PE composite pipe shall be pressure rated for maximum water pressures of 1.38 MPa at 23°C and 1.10 MPa at 60°C.

21.10.3 Jointing

While jointing PE-AL-PE pipes, following steps are required to be taken to ensure a leak proof and strong pipe joint:-

(a) Cut the pipe square by cutter to the required and proper length.
(b) Select the fitting to be used and dismantle its nuts and split rings.
(c) Place the nut and split ring over the pipe. Ensure that “O” rings are in proper position of insert.
(d) Prepare the end of pipe to be jointed for roundness and chamfer by using beveling tool. Push the pipe over the insert and inside the support groove fully.
(e) Push the split ring and nut towards connector till split ring touches the support groove.
(f) Tighten the nut over connector with spanner.
If the Joints are required to be dismantled for any reason, the ‘O’ ring and split ring should be inspected before reassembling the joint for any damage. If any ring is found damaged, the same should be replaced. All other components can be reused. The joint sealing with fittings is done by silicone rubber ring. No thread sealing is involved. Tightening of the nuts is required only for compressing the split ring over the pipe, hence excessive tightening of the nuts is to be avoided. In case threading is required for fixing valves and fixtures, then select the fittings already having male or female thread as per the requirement.

21.10.4 Fixing in Portion of PE-AL-PE pipes

For installation of PE-AL-PE pipes and fittings, following steps are required to be taken to ensure easy and faster installation:-

21.10.4.1 Measure the exact length of pipe required from fitting to fitting.

21.10.4.2 Cut pipe to required length by using PE-AL-PE pipe cutter to ensure clean and square cut. If the cut is not proper then the joint will not be proper/leak proof.

21.10.4.3 Use external bending spring for straightening of the PE-AL-PE pipes which are available in coils. If there are any bends in between then insert the external bending spring over the pipe and bend it to required angle. Move the spring after bending to next bending location. After putting the pipe in position completely, remove the spring. If the ends of pipes are required to be bend then the external bending spring may not support the pipe fully. In such cases, use internal bending spring. Use of bending springs facilitates bending of pipe to desired radius without causing any deformation to the pipes.

21.10.4.4 While connecting the fitting to the end of the pipe, follow the jointing procedure.

The PE-AL-PE pipe can be bent easily to the required shape. The bending shall be done in such a way that the bending radius is not less than 5 times the outer diameter of the pipe. As the pipe stays in shape, elbows are generally not required. Due to the unique jointing system, unions are not at all required. Bending of PE-AL-PE pipe in ‘L’ shape is not recommended. Use elbow in case it is absolutely necessary.

21.10.4.5 PE-AL-PE pipe can be installed in both internal and external work. For concealed work the walls can be recessed by hand or mechanical router for speed. Where PE-AL-PE pipe are installed on the surface, the maximum clipping center should be kept as shown in Table 21.24.

Table 21.24

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Horizontal (mm)</th>
<th>Vertical (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1216</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>1620</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td>2025</td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>2532/3250</td>
<td>1200</td>
<td>1500</td>
</tr>
</tbody>
</table>
The pipes installed on surface must have two additional clamps at fittings other than specified above.

21.10.4.6 It is necessary to provide clip/hook at the threaded fittings.

21.10.4.7 Only Teflon Tape should be used on threads instead of ‘Dhaag/Safeda’. While for fittings, specially designed rubber “Seal” should be used.

21.10.5 For pressure testing the pipe line system, specially designed test plugs are to be used in female thread elbows instead of ordinary GI nipples with MS plugs before covering the pipes in chases.

21.10.6 Diameter of pipes should be increased from 16mm OD to 20 mm OD when the user points exceed three. The head recommended for flush valve in gravity flow system is minimum 10 meters for 3240 mm size pipe. For optimum calculations and further design IS 15450 and “manufacturer’s plumbing design guidelines” should be referred.

21.10.7 Storing Precautions

21.10.7.1 PE-AL-PE pipe should be stacked carefully so as to prevent them from falling or causing damage with any external sharp edged material. PE-AL-PE pipe is a tough material but needs greater protection from accidental damages when installed in comparison to metallic pipes.

21.10.7.2 Where PE-AL-PE pipe is to be connected to heavy items such as pumps or valves it is likely to imposed under strain in the pipes hence the pump or valve should be supported directly using the support bracket.

21.10.7.3 The PE-AL-PE pipe are malleable, hence these should be protected from any heavy load impact and drilling etc. Where these pipes are provided under the ground, adequate cover as per IS 15450 should be provided.

21.10.8 The maximum allowable parameters for various components of PE-AL-PE piping system are given in Table 21.25.

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Service temperature deg “C”</th>
<th>Maximum allowable service pressure in bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Ambient</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

Before the pipes are covered or put to use, these should be tested for any leakage as per the following table:-
(The requirement of hydraulic test pressure are given in the following table at 20°C & 60°C temperature respectively using water.)

**TABLE 21.26**

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>1 Hour Test (20°C)</th>
<th>10 Hour Test (60°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1216</td>
<td>3.00</td>
<td>2.50</td>
</tr>
<tr>
<td>1620</td>
<td>2.70</td>
<td>2.50</td>
</tr>
<tr>
<td>2025</td>
<td>2.60</td>
<td>2.50</td>
</tr>
<tr>
<td>2532</td>
<td>2.30</td>
<td>2.10</td>
</tr>
<tr>
<td>3240</td>
<td>2.20</td>
<td>2.00</td>
</tr>
</tbody>
</table>

**21.11 MAKING CONNECTION OF G.I. DISTRIBUTION BRANCH WITH G.I. MAIN**

**21.11.1 Preliminary Work**

A pit of suitable dimensions shall be dug at the point where the connection is to be made with the main and earth removed upto 15cm below the main. The flow of water in the water main shall also be disconnected by closing the sluice or wheel valves on the mains.

**21.11.2 Making Connection**

For cutting and jointing 21.6.2 and 21.6.3 shall apply. The G.I. main shall first be cut. Water if any collected in the pit shall be bailed out and, ends of the G.I. pipes threaded. The connection of distribution pipe shall then be made after fixing G.I. tee of the required size to the G.I. main and fittings such as Jam nut, G.I. socket connecting piece etc.

**21.11.3 Testing of Joints**

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra payment.

The pipes & fittings after they are laid shall be tested to hydraulic pressure of 6Kg/sq.cm (60 m). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock of water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

**21.11.4 Finishing**
The portion of the pipe in the pit shall be painted with bitumastic paint and encased with sand 15 cm all-round. The pit shall be filled with earth in level with the original ground surface watered, rammed and the area dressed.

21.11.5 Measurements
The work of making connections shall be enumerated.

21.11.6 Rate
The rate shall include the cost of labour and materials involved in all the operations described above.

21.12 FIXING BRASS AND GUN METAL WATER FITTINGS
21.12.0 The fitting shall be fully examined and cleared of all foreign matter before being fixed. The fitting shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be leak-proof when tested to a pressure of 17.5 Kg/sq.cm. The defective fittings and joints shall be replaced or redone.

21.12.1 Measurement
Fittings shall be enumerated.

21.12.2 Rate
The rate shall include the cost of all the material and labour involved in all the operation described above.

21.13 FIXING FERRULES
21.13.1 For fixing ferrule the empty main shall be drilled and tapped at 45 degree to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

21.13.2 Measurements
Ferrule shall be enumerated.

21.13.3 Rate
The rate shall include the cost of all materials and labour involved in fixing the ferrule.

21.14 INSTALLATION OF FIRE HYDRANT
21.14.1 The hydrant shall be full examined and cleared of all foreign matter before being fixed. The fixing shall be done on the water main which shall be of minimum 80 mm dia. The flanged end of the hydrant shall be fixed to the flanged outlet of a tee in the water main by means of bolts, nuts and 3 mm rubber insertion or chemically treated compressed fiber board 1.5 mm minimum thickness and of weight not less than 0.183gm per sq. cm. This can also be fixed by means of flanged tail piece which may be connected to the water main by C.I. specials.

21.14.2 Measurement
Fire hydrant shall be enumerated.

21.14.3 Rate

The rate shall include the cost of materials and labour involved in all the operations described above against relevant item of work.

21.15. INSTALLATION OF SLUICE VALVE

21.15.1 The valve shall be fully examined and cleared of all foreign matter before being fixed. The fixing of the valve shall be done by means of bolts, nuts and 3 mm rubber insertions or chemically treated compressed fiber board 1.5 mm minimum thickness and of weight not less than 0.183 gm/sq.cm with the flanges of spigot and the socketed tail pieces drilled to the same specification in case of S&S pipes and with flanges in case of flanged pipes. The tail pieces shall conform to IS 1938. These shall be jointed to the pipe line by means of lead caulked joints.

21.15.2 Measurements

Sluice valve shall be enumerated.

21.15.3 Rate

The rate shall include the cost of material and labour involved in all the operations described above.

21.16 INSTALLATION OF WATER METER AND STOP VALVE

21.16.0 The G.I. line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends at the pipe shall then be threaded. The meter and stop cock shall be fixed in position by means of connecting pipes, G.I. jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the nipples of the meter shall be removed and the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the mater. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter. For this purpose a piece of pipe equal to the length of the meter shall be fitted in the proposed position of the meter in the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

21.16.1 Testing of Joints

Testing of joints shall be done as described in 21.6.6.

21.16.2 Measurements

The work of fixing meters and stop cocks shall be counted in numbers separately according to the diameters.

21.16.3 Rate
The rate shall include the cost of labour and materials involved in all the operations described above excluding the cost of stop cock and water meter.

21.17 **FIXING SURFACE BOX**

21.17.1 The C.I. surface box shall be fixed on the top of masonry chamber in plain or reinforced cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20mm nominal size) as the case may be.

21.17.2 **Measurements**

Masonry chamber shall be enumerated under the relevant items.

21.17.3 **Rate**

The rate shall include the cost of materials and labour involved in all the operations described above, except the excavation in saturated soils, soft or decomposed and hard rock if met with. The difference of cost, between ordinary soil and saturated soil or soft or decomposed or hard rock as the case may be, shall be paid for separately.

21.18 **POLYETHYLENE WATER STORAGE TANKS**

21.18.1 **Material**

Polyethylene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LLDPE) or linear low density (LMDPE) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminate the water nor impart any taste, colour, odour or toxicity to water.

21.18.2 **Manufacture and Finish**

The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

21.18.3 **Shape, Size and Capacity**

The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer’s specifications and a clearance of ± 3 percent shall be permitted on these dimensions. Capacity of the tank shall be specified. Extra capacity if any shall be ignored.

21.18.4 **Weight and Wall Thickness**
Minimum weight of the empty tank (exclusive of manhole lid fittings) and the minimum wall thickness of top, bottom and sides shall be specified in Table 21.27. Wall thickness shall be checked beyond 150 mm of the edge where the direction the plane of tank surface changes.

21.18.5 Installation and Fittings

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering or leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

21.18.6 Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter into the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

21.18.7 The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

21.18.8 Measurements

Dimensions shall be measured to the nearest cm. and weight of the empty tank shall be recorded to the nearest 100g. Capacity of the tank as defined in 21.18.3 shall be calculated to the nearest litre.

**TABLE 21.27**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Capacity Litres</th>
<th>Minimum Wall Thickness mm</th>
<th>Minimum Weight of Empty Tank Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>200</td>
<td>4.4</td>
<td>7.8</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>4.4</td>
<td>9.0</td>
</tr>
<tr>
<td>3.</td>
<td>400</td>
<td>5.5</td>
<td>15.0</td>
</tr>
<tr>
<td>4.</td>
<td>500</td>
<td>6.0</td>
<td>18.0</td>
</tr>
<tr>
<td>5.</td>
<td>700</td>
<td>6.6</td>
<td>23.0</td>
</tr>
<tr>
<td>6.</td>
<td>1000</td>
<td>7.0</td>
<td>33.0</td>
</tr>
<tr>
<td>7.</td>
<td>1250</td>
<td>7.0</td>
<td>40.0</td>
</tr>
<tr>
<td>8.</td>
<td>1500</td>
<td>7.0</td>
<td>47.0</td>
</tr>
<tr>
<td>9.</td>
<td>1700</td>
<td>7.0</td>
<td>54.0</td>
</tr>
<tr>
<td>10.</td>
<td>2000</td>
<td>8.2</td>
<td>64.0</td>
</tr>
<tr>
<td>11.</td>
<td>2500</td>
<td>8.2</td>
<td>81.0</td>
</tr>
<tr>
<td>12.</td>
<td>3000</td>
<td>8.8</td>
<td>96.0</td>
</tr>
<tr>
<td>S.No.</td>
<td>Capacity Litres</td>
<td>Minimum Wall Thickness mm</td>
<td>Minimum Weight of Empty Tank Kg</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
<td>---------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>13.</td>
<td>4000</td>
<td>10.4</td>
<td>138.0</td>
</tr>
<tr>
<td>14.</td>
<td>5000</td>
<td>10.7</td>
<td>191.0</td>
</tr>
<tr>
<td>15.</td>
<td>6000</td>
<td>10.7</td>
<td>209.0</td>
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<td>16.</td>
<td>7500</td>
<td>10.7</td>
<td>250.0</td>
</tr>
<tr>
<td>17.</td>
<td>10000</td>
<td>11.5</td>
<td>363.0</td>
</tr>
<tr>
<td>18.</td>
<td>15000</td>
<td>11.5</td>
<td>550.0</td>
</tr>
<tr>
<td>19.</td>
<td>20000</td>
<td>13.2</td>
<td>814.0</td>
</tr>
</tbody>
</table>

**21.18.9 Rates**

The rate shall include the cost of the tank, manhole lid, carriage and delivery at the place specified. Hoisting, installation, fittings, platform and anchoring shall be payable separately.

**21.19 CUTTING HOLES IN WALL UPTO 30 X 30 CM**

21.19.0 Square holes of size as specified or as directed by the Engineer-in-Charge shall be cut in the masonry. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-in-Charge. All dismantled material shall be removed from the site.

**21.19.1 Masonry Work**

Brick work etc. shall be made good by using the same class of brick, tile or stone masonry as was cut during the execution of work. The mortar to be used shall be cement mortar 1:4 (1 cement: 4 fine sand) or as directed by the Engineer-in-Charge.

**21.19.2 Finishing**

Cement mortar in 1:4 mix (1 cement: 4 sand) shall be used for plastering or pointing, as may be required. Sand shall be fine or coarse, as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or painting as required but where the surfaces is not to be white washed, colour washed, distempered; it shall be finished smooth with a floating coat of neat cement or as required to match with the surrounding surfaces.

**21.19.3 Measurements**

The holes shall be enumerated.

**21.19.4 Rate**

The rate shall include the cost of labour and materials required for all the operations describe above.

**21.20 CUTTING HOLES IN R.C.C. FLOORS (UPTO 15 X 15 CM)**
21.20.0 Square holes of size as specified shall be cut in R.C.C. floor and roofs for passing drain pipe etc. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-in-Charge. All the dismantled material shall be removed from the site.

21.20.1 Cement Concrete

After insertion of drain pipe etc. the hole shall be repaired with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20mm nominal size) and the surface finished to match with the existing surface. The top and bottom shall be finished properly to make the joint leak proof. The specifications for cement concrete work and finishing etc. shall be the same as detailed under relevant sub-heads.

21.20.2 Measurements

Holes shall be enumerated.

21.20.3 Rate

The rate shall include the cost of labour and material required for all the operations described above except the pipe which shall be paid for separately.

21.21 CUTTING CHASES IN MASONRY WALLS

21.21.1 Making Chases

Chases are made in the walls for housing G.I. Pipes etc.

I. Cutting of chases in one brick thick and above load bearing walls:

(i) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.

(ii) The depths of vertical chases and horizontal chases shall not exceed one third and one sixth of the thickness of the masonry respectively.

(iii) When narrow stretches of masonry (or short lengths of walls) such as between doors and windows, cannot be avoided, they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration, such narrow lengths of walls shall be checked for stresses and high strength bricks mortar or concrete walls provided, if required.

(iv) Horizontal chases when unavoidable should be located in the upper or lower one third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.

(v) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearing of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.

(vi) Masonry directly above a recess, if under than 30 cm (Horizontal dimension) should be supported on lintel. Holes in masonry may be provided upto 30 cm width x 30 cm height without any lintel. In the case of circular holes in masonry, no lintel should be provided upto 40 cm in diameter.
II. Cutting of chases in half brick load bearing walls

No chase shall be permitted in a half brick load bearing wall and as such no recessed conduits and concealed pipes shall be provided in half brick thick load bearing walls.

III Cutting of chases in half brick non-loading bearing walls

In case of non load bearing half brick walls services should be planned with the help of vertical chases. Horizontal chases should be provided only when unavoidable.

IV Cutting of chases in stone masonry walls

The provision (i) to (iv) under Sl. No. I are equally applicable to stone masonry walls also.

Note:

1. No inclined chase shall be permitted in brick masonry or stone masonry walls. In case inclined chases are unavoidable these shall be cut with written approval of the Engineer-in-Charge, and shall be repaired properly to his satisfaction. However, in half brick masonry wall, no inclined chases will be permitted.

2. Chases shall be made by chiseling out the masonry to proper line & depth. Any damage to the adjoining portion or to any other item shall be made good, as decided by the Engineer-in-Charge, for which no extra payment shall be made. All dismantled material shall be removed from site.

21.21.2 Filling Chases

After G.I. pipes etc. are fixed in chases, the chases shall be filled with cement concrete 1:3:6 (1 cement : 3 coarse sand: 6 graded stone aggregate 20mm nominal size) or cement mortar 1:4 (1 cement : 4 coarse sand) as may be specified or otherwise directed by the Engineer-in-Charge and made flush with the masonry surface. The concrete surface shall be roughened with wire brushes to provide a key for plastering.

21.21.3 Measurements

Chases shall be measured in running meter correct to a cm.

21.21.4 Rates

The rate shall include the cost of labour the materials involved in all the operations described above excluding the cost of providing pipes etc. which shall be paid separately.
TOLERANCES FOR CAST IRON (CENTRIFUGALLY CAST) PIPES

(Clause 21.3.10)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Nominal diameter (DN)</th>
<th>Tolerances in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) External diameter of barrel (DE)</td>
<td>All diameters</td>
<td>±1/2f=±(4.5+0.0015DN)</td>
</tr>
<tr>
<td>(b) Internal diameter of socket (DI)</td>
<td>All diameters</td>
<td>±1/3f=± (3+0.001 DN)</td>
</tr>
<tr>
<td>(c) Depth of socket (P)</td>
<td>(1) Upto and including 600mm</td>
<td>±5</td>
</tr>
<tr>
<td></td>
<td>(2) Over 600mm and up to and including 1000mm</td>
<td>±10</td>
</tr>
</tbody>
</table>

Note:

(1) f is the caulking space of the joint in millimeters and is equal to 9 + 0.003DN.

(2) The jointing tolerances applicable to rubber joints (mechanical or push in joints) shall be specified by their manufacturer and shall be within the tolerances specified above.

**Tolerance on Thickness**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Tolerance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Wall thickness</td>
<td>-(1+0.05 e)</td>
</tr>
<tr>
<td>(b) Flange thickness</td>
<td>±(2+0.05 b)</td>
</tr>
</tbody>
</table>

Where e = is the thickness of the wall in millimeters and

b = is the thickness of the flange in millimeters.

**Tolerance on Length**

<table>
<thead>
<tr>
<th>Type of Casting</th>
<th>Tolerance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Socket and spigot, and plain ended pipes</td>
<td>±25</td>
</tr>
<tr>
<td>(b) Flanged pipes</td>
<td>±10</td>
</tr>
</tbody>
</table>

(See Chapter 1 also)
## TOLERANCES FOR SPECIALS OF CAST IRON PIPES

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Nature of Joint</th>
<th>Nominal diameter (DN)</th>
<th>Tolerances in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>External diameter of spigot (DE) f or ± (4.5+0.0015DN)</td>
<td>Lead Joints</td>
<td>All diameters</td>
<td>± ½</td>
</tr>
<tr>
<td>Internal diameter of socket (DI) f or ± (3 + 0.001 DN)</td>
<td>Lead Joints</td>
<td>All diameters</td>
<td>± 1/3</td>
</tr>
<tr>
<td>Depth of socket (P)</td>
<td>Lead Joints</td>
<td>Upto and including 600mm</td>
<td>± 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 600mm upto and including 1000mm</td>
<td>± 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 1000mm upto and including 1500mm</td>
<td>± 15</td>
</tr>
</tbody>
</table>

### Tolerance on Thickness

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Tolerance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Wall thickness</td>
<td>-(2+0.05 e)</td>
</tr>
<tr>
<td>(b) Flange thickness</td>
<td>± (3+0.05 b)</td>
</tr>
</tbody>
</table>

Where e = is the thickness of the wall in millimeters and
b = is the thickness of the flange in millimeters.

### Tolerance on Length

<table>
<thead>
<tr>
<th>Type of fitting</th>
<th>Nominal diameter</th>
<th>Tolerance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socket fittings and flange spigot pieces</td>
<td>Upto and including 450mm</td>
<td>± 20</td>
</tr>
<tr>
<td></td>
<td>Over 450mm</td>
<td>± 20 – 30</td>
</tr>
<tr>
<td>Flanged fittings</td>
<td>All diameters</td>
<td>± 10</td>
</tr>
</tbody>
</table>

(See Chapter 1 also)
### Particulars of Medium Grade G.I. Pipes

<table>
<thead>
<tr>
<th>Nominal bore</th>
<th>Dimension of Pipes</th>
<th>Weight of pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outside (mm)</td>
<td>Min (mm)</td>
</tr>
<tr>
<td>6</td>
<td>10.6</td>
<td>9.8</td>
</tr>
<tr>
<td>8</td>
<td>14.00</td>
<td>13.2</td>
</tr>
<tr>
<td>10</td>
<td>17.5</td>
<td>16.7</td>
</tr>
<tr>
<td>15</td>
<td>21.8</td>
<td>21.0</td>
</tr>
<tr>
<td>20</td>
<td>27.3</td>
<td>26.5</td>
</tr>
<tr>
<td>25</td>
<td>34.2</td>
<td>33.3</td>
</tr>
<tr>
<td>32</td>
<td>42.9</td>
<td>42.0</td>
</tr>
<tr>
<td>40</td>
<td>48.8</td>
<td>47.9</td>
</tr>
<tr>
<td>50</td>
<td>60.8</td>
<td>59.7</td>
</tr>
<tr>
<td>65</td>
<td>76.6</td>
<td>75.3</td>
</tr>
<tr>
<td>80</td>
<td>89.5</td>
<td>88.0</td>
</tr>
<tr>
<td>100</td>
<td>115.0</td>
<td>113.1</td>
</tr>
<tr>
<td>125</td>
<td>140.8</td>
<td>138.5</td>
</tr>
<tr>
<td>150</td>
<td>166.5</td>
<td>163.9</td>
</tr>
</tbody>
</table>

**Tolerance in Thickness and Weight**

**A) Thickness**

1. Butt welded medium tubes  
   - ± not limited  
   - 10 per cent
2. Seamless tables  
   - ± not limited  
   - 12.5 per cent

**B) Weight**

1. Single tube (light series)  
   - ± 10 percent
2. Single tube (medium and heavy series)  
   - ± 10 percent
3. For quantities per load of 10 tonnes, min (light series)  
   - ± 5 percent  
   - 8 percent
4. For quantities per load of 10 tonnes, min
   (medium and heavy series) ± 7.5 percent
   (See Chapter 7 also)
ANNEXURE-D

PROCEDURE FOR PRESSURE TEST (Applicable for all pipe line works)
(Clause 21.5.6)

1. Each valved section of the pipe shall be slowly filled with water and all air available at high places, necessary tapping may be made at points of highest elevation before the test is made and plugs inserted after the tests have been completed.

2. If the trench has been partially back-filled the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer-in-Charge. The duration of the test shall not be less than 5 minutes.

3. Examination under Pressure: All exposed pipes, fittings, valves, hydrants and joints should be carefully examined during the open-trench test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked until tight. When the joints are made with cement and show seepage or slight leakage, such joints shall be cut out and replaced as directed by the authority. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall be repeated until satisfactory to the Engineer-in-Charge.

4. If the trench has been back-filled to the top, the section shall be first subjected to water pressure normal to the area and the exposed parts shall be carefully examined. If any defects are found, they shall be repaired and the pressure test repeated until no defects are found. The duration of the final pressure tests shall be at least one hour.

Procedure for Leakage Test

5. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No pipe installation shall be accepted until the leakage is less than the number of cm³/h determined by the formula:

\[
ql = \frac{ND\sqrt{p}}{3.3}
\]

Where:
- \(ql\) = the allowable leakage in cm³/h.
- \(N\) = Number of joints in the length of the pipe line.
- \(D\) = diameter in mm, and
- \(P\) = the average test pressure during the leakage testing kg/cm².

6. Variation from Permissible Leakage: Should any test of pipe laid in position discloses leakage greater than that specified in Para 5 the defective joints shall be repaired until the leakage is within the specified allowance.
GUIDELINES FOR STORAGE AND INSTALLATION OF CPVC PIPES
(Clause 21.9)

E-1 STORAGE

CPVC pipes of all sizes are packed in polyethylene packing rolls and both the ends of the packed roll are sealed with air bubble film cap in order to provide protection during handling and transportation. After packing, the whole bunch of pipes is tightened with polypropylene/ HDPE strapping. Each role is then marked with size/type of the pipe, lot number and quantity. The packed pipe rolls are stored in their respective racks in properly covered storage area. Apart from providing protection during handling and transportation, the packing rolls also protect the pipe from ultra violet rays.

E-2 INSTALLATION GUIDELINES

E-2.1 Visually inspect pipe ends before making the joint. Use of a chamfering tool will help identify and cracks, as it will catch on to any crack.

E-2.2 Pipe may be cut quickly and efficiently by several methods. Wheel type plastic tubing cutters are preferred. Ratchet type cutter or fine tooth saw are another options. However, when using the ratchet cutter be certain to score the exterior wall by rotating the cutter blade in circular motion around the pipe. Do this before applying significant downward pressure to finalize the cut. This step leads to a square cut. In addition, make sure ratchet cutter blades are sharp. Cutting tubing as squarely as possible provides optimal bonding area within a joint.

E-2.3 Burrs and fillings can prevent proper contact between the tube and fittings during the assembly, and should be removed from the outside and inside of the tube. A chamfering tool is preferred, but a pocket knife or file is also suitable for this purpose.

E-2.4 Use CPVC cement jointing. Use CPVC cement, which is fully recommended by the manufacturer.

E-2.5 When using adhesive solution/solvent cement to certain of proper ventilation.

E-2.6 When making a join, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged waterways. Do not allow excess cement to puddle in the fitting and pipe assembly. This could result in a weakening of the pipe wall and possible pipe failure when the system is pressurized.

E-2.7 Rotate pipe one-quarter to one-half turn while inserting it into the fitting socket and remove the excess adhesive solution/solvent cement from the joint with clean rag.
E-2.8 When making a transition connection to metal threads, use a special transition fitting of CPVC male threaded adapter whenever possible. Do not over-torque plastic threaded connections. Hand tight plus one-half turn should be adequate.

E-2.9 Hang or strap CPVC systems loosely to allow for thermal expansion. Do not use metal straps with sharp edges that might damage the tubing.

E-2.10 CPVC stub outs for lavatories, closets and sinks are appropriate. However, on areas where there is a likelihood that movement or impact abuse will occur, metal pipe nipples may be more appropriate stub-out material. Showerheads, tub spouts and outside still cocks are examples.

E-2.11 When connected to gas water heater, CPVC tubing should not be located within 50 cm of the flue. For water heaters lacking reliable temperature control, this distance may be increased up to 1 m a metal nipple or flexible appliance connector should be utilized. This measure eliminates the potential for damage to plastic piping that might result from excessive radiant heat from the flue.
F-1  ACCEPTANCE TESTS

F-1.1  Acceptance test are carried out on samples selected from a lot for the purpose of acceptance of the lot.

F-1.2  Lot

All CPVC pipes in a single consignment of the same class, same size and manufactured under essentially similar conditions shall constitute a lot.

F-1.3  For ascertaining conformity of the lot to the requirements of the specification, samples shall be tested from each lot separately.

F-1.4  Visual and Dimensional Requirements

F-1.4.1  The number of test samples to be taken from a lot shall depend on the size of the lot and the outside diameter of the pipe, and shall be in accordance with Table F-1.

Scale of Sampling of Visual Appearance and Dimensional Requirements

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Number of pipes in the lot</th>
<th>Sample number</th>
<th>Sample size</th>
<th>Cumulative sample size</th>
<th>Acceptance number</th>
<th>Rejection number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Up to 1000</td>
<td>First</td>
<td>13</td>
<td>13</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>13</td>
<td>26</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(ii)</td>
<td>1001 to 3000</td>
<td>First</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>20</td>
<td>40</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(iii)</td>
<td>3001 to 10000</td>
<td>First</td>
<td>32</td>
<td>32</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>32</td>
<td>64</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(iv)</td>
<td>10001 &amp; above</td>
<td>First</td>
<td>50</td>
<td>50</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>50</td>
<td>100</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

F-1.4.2  These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used. For guidance and use of random number tables, IS-4905 may be referred to. In the absence of a random number table, the following procedure may be adopted:

Starting from any pipe in the lot, count them as 1,2,3 etc. up to r and so on, where r is the integral part of N/n, N being the number of pipes in the lot, and n the number of pipes in the sample. Every rth pipe so counted shall be withdrawn so as to constitute the required sample size.

F-1.4.3  The number of pipes given for the first sample in col. 4 of Table F-1, shall be taken from the lot and examined for visual and dimensional requirements given in Table 8.18 and 8.9.4.1. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied
these requirements, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col. 6 of Table F-1. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col. 7 of Table F-1. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in cols. 6 and 7, a second sample of the size given in col. 4 shall be taken and examined for the requirements. The lot shall be considered to have satisfied these requirements. The lot shall be considered to have satisfied these requirements if the cumulative sample is less than or equal to the corresponding acceptance number given in col. 6, otherwise not.

F-1.5  Reversion Test

F-1.5.1  The lot, having satisfied visual and dimensional requirements, shall be tested for reversion as given in 21.9.4.4.

F-1.5.2  For this purpose, the number of pipes given for the first sample in col. 4 of Table F-2 shall be taken from the lot. The sample pipe failing the reversion test shall be considered as defective. The lot shall be deemed to have met the requirements given in this specification for the reversion test, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col. 6. This lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col. 7 if, however, the number of defectives in the first sample lies between the corresponding acceptance and rejection numbers given in col. 6 and col. 7, a second sample of size given in col. 4 shall be taken and examined for the requirements. The lot shall be considered to have satisfied the requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col. 6, otherwise not.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Number of pipes in the lot</th>
<th>Sample number</th>
<th>Sample size</th>
<th>Cumulative sample size</th>
<th>Acceptance number</th>
<th>Rejection number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>(i)</td>
<td>Up to 1000</td>
<td>First</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(ii)</td>
<td>1001 to 3000</td>
<td>First</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>8</td>
<td>16</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(iii)</td>
<td>3001 to 10000</td>
<td>First</td>
<td>13</td>
<td>13</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>13</td>
<td>26</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(iv)</td>
<td>10001 &amp; above</td>
<td>First</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>20</td>
<td>40</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

F-1.6  Vicat Softening Test
The lot, having satisfied visual and dimensional requirements shall be tested for Vicat softening temperature as given in 8.9.4.5.

For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that for reversion under F-1.5.2 using Table F-2.

The lot, having satisfied the visual and dimensional requirements, shall be tested for density as given in 8.9.4.6.

For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that for reversion under F-1.5.2 using Table F-2.

The lot, having been found satisfactory according to F-1.4, F-1.5, F-1.6 and F-1.7 shall be tested for resistance to external blow at 0°C as given in 8.9.5.3

For this purpose, the procedure adopted for sampling and criteria for conformity shall be as specified in Table 8.20 and Table below.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Number of pipes in the lot</th>
<th>Sample number</th>
<th>Sample size</th>
<th>Cumulative sample size</th>
<th>Acceptance number</th>
<th>Rejection number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>(i)</td>
<td>Up to 3000</td>
<td>First</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(ii)</td>
<td>3001 to 10000</td>
<td>First</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>5</td>
<td>10</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>(iii)</td>
<td>10000 &amp; above</td>
<td>First</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Second</td>
<td>8</td>
<td>10</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

The number of pipes to be taken from the lot shall depend on the size of the lot and shall be according to Table F-4.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Number of Pipes in the lot</th>
<th>Sample size</th>
<th>Acceptance number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(i)</td>
<td>Up to 3000</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>(ii)</td>
<td>3001 to 10000</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>(iii)</td>
<td>10000 &amp; above</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

The pipes shall be taken at random from the lot. In order to ensure the randomness of selection, procedures given in IS 4905 may be followed.
F-1.9.3 Number of Tests and Criteria for Conformity

The number of test samples shall be as given in Table F-4. The lot shall be considered to have satisfied the requirements for this test, if the number of test samples failing in this requirement is equal to the corresponding acceptance number given in column 4 of Table F-4.

F-2 TYPE TESTS

F-2.1 Type tests are intended to prove the suitability and performance of a new composition or a new size of pipe. Such tests, therefore, need to be applied only when a change is made in polymer composition or when a new size of pipes is to be introduced. Type test for compliance with 21.9.4.2, 21.9.4.3, 21.9.5.1 (Type test only) and 21.9.5.4 shall be carried out.

F-2.1.1 Verification of Malfunction Temperature $T_{mal}$

For this test, the manufacturer to the testing authority one assembly, selected preferably from a regular production lot.

F-2.1.2 Opacity

For this test, the manufacturer or the supplier shall furnish to the testing authority one sample of the pipe of the thinnest wall section, selected preferably from a regular production lot.

F-2.1.2.1 The sample so selected shall be tested for compliance with requirements for opacity as given in 21.9.4.2

F-2.1.2.2 If the sample passes the requirements of the opacity test, the type of the pipe under consideration shall be considered to be eligible for approval, which shall be valid for a period of one year.

F-2.1.2.3 In case the sample fails in the test, the testing authority, at its discretion, may call for a fresh sample and subject the same to the opacity test. If the sample passes the repeat test, the type of pipe under consideration shall be considered eligible for approval. If the sample fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and re-submit the product for type approval.

F-2.1.2.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for a fresh sample for opacity test for the purpose of type approval.

F-2.1.3 Test for Effect on Water

For this type test, the manufacturer or the supplier shall furnish to the testing authority three samples of the smallest size of pipe taken from each machine (selected preferably from a regular production lot).

F-2.1.3.1 Three samples so selected shall be tested for compliance with the requirements for effect on water as given in 21.9.4.3.
2.1.3.2 If all three samples pass the requirements for effect on water, the type test of the pipe under consideration shall be considered to be eligible for approval, which shall be normally valid for a period of one year.

2.1.3.3 In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number, and subject them to the test for effect on water. If, in the repeat test, no single failure occurs, the type of pipe under consideration shall be considered eligible for type approval. If any of the samples fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

2.1.3.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for effect on water test for the purpose of type approval.

2.1.4 Internal Hydrostatic Pressure Test (Type Test) and thermal Stability

For this type test, the manufacturer or the supplier shall furnish to the testing authority, three samples of pipes of different diameters and different classes (selected preferably from a regular production lot).

2.14.1 Three samples so selected shall be tested for compliances with the requirements of type test given in 21.9.4.3.

2.14.2 If all the three samples pass the requirements of the quality test, the type of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.

2.14.3 In case any of the sample fail in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test. If, in the repeat test, no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

2.14.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

2.1.5 Tensile Strength Test (Type Test)

For this type test, the manufacturer or the supplier shall furnish to the testing authority, five samples of pipe of different diameters and different class (selected preferably from a regular production lot).

2.15.1 Five samples so selected shall be tested for compliance with the requirements of type test given in 21.9.5.4.

2.15.2 If all the five samples pass the requirement of the quality test, the type test of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.
F-2.1.5.3 In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original numbers and subject them to the type test. If, in the repeat test no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fail in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

F-2.1.5.4 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

UNDERGROUND FIRE HYDRANT, SLUICE-VALVE GATE

Fig. 1: Underground Fire Hydrant, Sluice-Valve Gate

All Dimensions are in MM.
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Mat</th>
<th>Mat Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body</td>
<td>Cl</td>
<td>IS 210-1972 FG-200</td>
</tr>
<tr>
<td>2</td>
<td>Valve seat</td>
<td>G.M.</td>
<td>IS 318-1981 LTB-2</td>
</tr>
<tr>
<td>3</td>
<td>Washer</td>
<td>Rubber</td>
<td>IS 937-1981</td>
</tr>
<tr>
<td>4</td>
<td>Valve</td>
<td>G.M.</td>
<td>IS 318-1981 LTB-2</td>
</tr>
<tr>
<td>6</td>
<td>Bonnet</td>
<td>C.I.</td>
<td>IS 210-1978 FG-200</td>
</tr>
<tr>
<td>7</td>
<td>Spindle</td>
<td>Brass</td>
<td>IS 319-1989</td>
</tr>
<tr>
<td>8</td>
<td>Gland</td>
<td>C.I.</td>
<td>IS 210-1978 FG-200</td>
</tr>
<tr>
<td>9</td>
<td>Grush Screw (12 mm)</td>
<td>M.S.</td>
<td>IS 6094-1981</td>
</tr>
<tr>
<td>10</td>
<td>Spindle Cap</td>
<td>C.I.</td>
<td>IS 210-1978 FG-200</td>
</tr>
<tr>
<td>11</td>
<td>Drain Bolt</td>
<td>M.S.</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Outlet</td>
<td>G.M.</td>
<td>IS 318-1981 LTB-2</td>
</tr>
<tr>
<td>13</td>
<td>Cap</td>
<td>C.I.</td>
<td>IS 210-1978 FG-200</td>
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<tr>
<td>14</td>
<td>Chain</td>
<td>Gal. MS</td>
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</tr>
<tr>
<td>15</td>
<td>Nut and Bolt</td>
<td>M.S.</td>
<td>-</td>
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</table>
MASONRY CHAMBERS & SURFACE BOXES

FOR FIRE HYDRANT

FOR WATER METER

SACTION XY

SACTION CD

PLAN

PLAN

SURFACE BOX

SURFACE BOX

SECTION AA

SECTION BB

Drawing Not to Scale
All Dimensions are in MM

Fig. 2: Masonry Chambers & Surface Boxes
MASSONRY CHAMBERS & SURFACE BOXES

FOR STOP COCK

FOR SLUICE VALVE

SECTION A B

SECTION X Y

PLAN

PLAN

SURFACE BOX FOR STOP COCK

SURFACE BOX FOR SLUICE VALVE

Drawing not to scale
All Dimensions are in MM

Fig. 3: Masonry Chambers & Surface Boxes
22. BUILDING DRAINAGE
<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Brief Description</th>
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</thead>
<tbody>
<tr>
<td>22.1</td>
<td>Applicable Codes</td>
</tr>
<tr>
<td>22.2</td>
<td>ENGINEERING</td>
</tr>
<tr>
<td>22.3</td>
<td>Glazed Stone Ware Pipes and Fittings</td>
</tr>
<tr>
<td>22.4</td>
<td>Laying and Jointing Stone Ware Pipes</td>
</tr>
<tr>
<td>22.5</td>
<td>S.W. Gully Trap</td>
</tr>
<tr>
<td>22.6</td>
<td>Fixing S.W. Gully Trap</td>
</tr>
<tr>
<td>22.7</td>
<td>Cement Concrete Pipes (with and without Reinforcement) (Light Duty, Non-Pressure)</td>
</tr>
<tr>
<td>22.8</td>
<td>Laying and Jointing Cement Concrete Pipes and Specials</td>
</tr>
<tr>
<td>22.9</td>
<td>Cast Iron (Centrifugally Cast) Pipes and Specials</td>
</tr>
<tr>
<td>22.10</td>
<td>Road Gully Grating</td>
</tr>
<tr>
<td>22.11</td>
<td>MANHOLE COVERS &amp; FRAMES</td>
</tr>
<tr>
<td>22.12</td>
<td>MANHOLES</td>
</tr>
<tr>
<td>22.13</td>
<td>DROP CONNECTION</td>
</tr>
<tr>
<td>22.14</td>
<td>OPEN SURFACE DRAIN</td>
</tr>
<tr>
<td>22.15</td>
<td>Road gully chamber with grating</td>
</tr>
<tr>
<td>22.16</td>
<td>Brick masonry gully trap</td>
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<tr>
<td>22.17</td>
<td>SEPTIC TANK</td>
</tr>
<tr>
<td>22.18</td>
<td>SOAK PITS 2.5 M DIA X 3 M DEEP</td>
</tr>
<tr>
<td>22.19</td>
<td>SOAK PIT 1.2 x 1.2 x 1.2 M</td>
</tr>
<tr>
<td>22.20</td>
<td>DISPERSION TRENCH</td>
</tr>
<tr>
<td>22.21</td>
<td>DESLUDGING OF SEPTIC TANKS</td>
</tr>
</tbody>
</table>
CHAPTER NO. 22
BUILDING DRAINAGE

Table No. 22.1

22.1 Applicable Codes

<table>
<thead>
<tr>
<th>IS Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>IS 458</td>
<td>Pre-cast Concrete Pipes (with and without reinforcement)</td>
</tr>
<tr>
<td>IS 651</td>
<td>Specification for Salt Glazed Stoneware Pipes and Fittings.</td>
</tr>
<tr>
<td>IS 783</td>
<td>Code of Practice for Laying Concrete Pipes.</td>
</tr>
<tr>
<td>IS 1726</td>
<td>Specification for Cast Iron Manhole Covers and Frames</td>
</tr>
<tr>
<td>IS 1729</td>
<td>Cast Iron/Ductile Iron Drainage Pipes and Pipe Fittings</td>
</tr>
<tr>
<td>IS 4127</td>
<td>Code of Practice for Laying of Glazed Stone Ware Pipes</td>
</tr>
<tr>
<td>IS 4885</td>
<td>Specifications for Sewer Bricks</td>
</tr>
<tr>
<td>IS 12592</td>
<td>Pre-cast Concrete Manhole Covers and Frames - Specifications.</td>
</tr>
</tbody>
</table>

22.2 ENGINEERING

22.2.1 In designing a drainage system for building(s), the aim shall be to provide a self cleansing conduit for the conveyance of soil, waste, surface or sub-surface waters and for the removal of such wastes speedily and efficiently to a sewer or other outlet, without nuisance and hazard to health.

22.2.2 The discharge of water through a domestic drain is intermittent and limited in quantity and therefore, small accumulations of solid matter are liable to form in the drains between the building and the public sewer. Gradients shall be sufficient to prevent temporary accumulations building up and blocking the drains.

22.2.3 The minimum velocity shall on no account be less than 0.61 metres per second.

22.2.4 On the other hand, it is undesirable to employ gradients giving velocity of flow greater than 2.4 metres per second. Where it is unavoidable, cast iron pipes shall be used. The approximate gradients which given a velocity of 2.4 metres per second for the various sizes of pipes and the corresponding discharge when flowing half-full are given in Table 22.2
TABLE 22.2
Gradients for Sewers

<table>
<thead>
<tr>
<th>Diameter mm</th>
<th>Minimum Gradient</th>
<th>Maximum Gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gradients</td>
<td>Discharge cum/Min.</td>
</tr>
<tr>
<td>100</td>
<td>1 in 57</td>
<td>0.18</td>
</tr>
<tr>
<td>150</td>
<td>1 in 100</td>
<td>0.42</td>
</tr>
<tr>
<td>200</td>
<td>1 in 145</td>
<td>0.73</td>
</tr>
<tr>
<td>230</td>
<td>1 in 175</td>
<td>0.93</td>
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<tr>
<td>250</td>
<td>1 in 195</td>
<td>1.10</td>
</tr>
<tr>
<td>300</td>
<td>1 in 250</td>
<td>1.70</td>
</tr>
</tbody>
</table>

22.3 Glazed Stone Ware Pipes and Fittings.

22.3.1 All pipes with spigot and socket ends and fittings shall conform to class SP1 of IS 651. These shall be sound, free from visible defects such as fire cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear tone when struck with a light hammer. There shall be no broken blisters.

22.3.2 The length of pipes shall be 60, 75, 90 cm exclusive of the internal depth of the socket. The pipes shall be handled with sufficient care to avoid damage to them.

22.4 Laying and Jointing Stone Ware Pipes:

For all sewers and drains, glazed stoneware pipes shall be used as far as possible in preference to other types of pipes. These are suitable, particularly where acid effluents or acid sub-soil conditions are likely to be encountered.

22.4.1 Trenches: Specifications described in IS code 4127:1983 shall be followed.

The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipe line is under a roadway, a minimum cover of 90 cm is recommended for adoption, but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the Engineer-in-Charge. The trench shall be so shored and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains.

The excavation shall be carried out with manual labour or with suitable mechanical equipments as approved by the Engineer-in-Charge.

Unless otherwise specified by the Engineer-in-Charge, the width at bottom of trenches for different diameters of pipes laid at different depths shall be as given below:-
22.4.1.1 For all diameters, up to an average depth of 120 cm, width of trench in cm =
diameter of pipe + 30 cm.

22.4.1.2 For all diameters for depths above 120 cm, width of trench in cm = diameter of
pipe + 40 cm.

22.4.1.3 Notwithstanding (a) and (b) the total width of trench shall not be less than 75
cm for depths exceeding 90 cm.

22.4.2 Laying : Where the pipes are laid on soft soil with maximum water table lying at
invert level of the pipe, the pipes shall be bedded in cement concrete with
thickness and mix as specified, projecting on each side of the pipe to the
specified width of the trench. The pipes with their crown level at 1.20 m depth
and less from ground shall be covered with 15 cm thick. Concrete above the
crown of the pipe and sloped off to meet the outer edges of the concrete, to
give a minimum thickness of 15 cm all-around the pipe. Pipes laid at a depth
greater than 1.20 m at crown and maximum water table level rising above the
invert level of pipe, shall be concreted at the sides up to the level of the centre
of the pipe and sloped off from the edges to meet the pipe tangentially.

The pipe shall be carefully laid to the alignments, levels and gradients shown
on the plans and sections. Great care shall be taken to prevent sand etc. from
entering the pipes. The pipes between two manholes shall be laid truly in a
straight line without vertical or horizontal undulation. The pipes shall be laid
with socket ends facing upstream. The body of the pipe shall for its entire
length rest on an even bed of concrete and places shall be excavated in the
concrete to receive the socket of the pipe.

Where pipes are not bedded on concrete, the trench floor shall be left slightly
high and carefully bottomed up as pipe laying proceeds, so that the pipe
barrels rest on firm and undisturbed ground. If the excavation has been carried
too low, the desired levels shall be made up with concrete 1:5:10 (1cement: 5
fine sand: 10 graded stone aggregate 40mm nominal size) for which no extra
payment shall be made.

If the floor of the trench consists of rock or very hard ground that cannot easily
be excavated to smooth surface the pipe shall be laid on a leveling course of
concrete as desired.

When S.W. pipes are used for storm water drainage, no concreting will
normally be necessary. The cement mortar for jointing will be 1:3 (1cement:
3fine sand). Testing of joints will also not be done.

22.4.3 Jointing: Tarred gasket or hemp yarn soaked in thick cement slurry shall first be
placed round the spigot of each pipe and the spigot shall then be slipped home
well into the socket of the pipe previously laid. The pipe shall then be adjusted
and fixed in the correct position and the gasket caulked tightly home so as to fill
not more than 1/4th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in
the proportion of 1:1 (1cement: 1 fine sand). When the socket is filled, a fillet
shall be formed round the joint with a trowel forming an angle of 45 degree with the barrel of the pipe.

After a day's work any extraneous material shall be removed from the inside of the pipe. The joints shall be cured for at least seven days.

22.4.4 Testing of Joints: Stoneware pipes used for sewers shall be subjected to a test pressure of 2.5m head of water at the highest point of the section under test. Before commencing test, the pipeline shall be filled with water and maintained full for 24 hours under head of 0.6m of water. The test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitable for observation. The tolerance of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 minutes.

If any leakage is visible, the defective part of the work shall be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe of joint shall be watched for and taken as indicating a defect to be made good.

Any joint found leaking of sweating, shall be rectified or embedded into 15 cm layer of cement concrete (1:2:4) 30 cm in length and the section retested.

22.4.5 Refilling: In cases where pipes are not bedded on concrete special care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe, and rammed with a shovel and light tamper. This method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe continued up to 60 cm above the top of pipe so as not to disturb the pipe. No. tamping should be done within 15 cm of the top of pipe.

22.4.6 Measurements : The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from, inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

22.4.7 Rate: The rate shall include the cost of materials and labour involved in all the operations described above excluding the cost of concrete which shall be paid for separately.

22.5. S.W. Gully Trap:
Gully traps shall conform to IS 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer. There shall be no broken blisters.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 Kg and the frame not less than 2.70 Kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machines seating faces.

22.6. **Fixing S.W. Gully Trap**

22.6.1 Excavation: The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge.

22.6.2 Fixing: The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:5:10 (1 cement : 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes described above.

22.6.3 Brick Masonry Chamber: After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300mm (inside) in brick work of specified class in cement mortar 1:4 (1 cement : 4 fine sand) shall be built with a half brick thick brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber wall and the trap shall be filled in the with cement concrete M5 graded stone aggregate 40mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I. cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete M15 graded stone aggregate 20mm nominal size) and rendered smooth. The finished top of cover shall be left about 4 cm above the adjoining ground level so as to excluded the surface water from entering the gully trap.

22.6.4 Measurement: The work shall be enumerated. Excavation shall be measured separately under relevant item of earth work.

22.6.5 Rate: The rate shall include the cost of materials and labour involved in all the operations described above, except earth work which shall be paid for separately.

22.7. **Cement Concrete Pipes (with and without Reinforcement) (Light Duty, Non-Pressure)**

22.7.1 The pipes shall be with or without reinforcement as required and shall be of class not lesser than NP2. These shall conform to IS 458 and shall be capable of withstanding a test pressure of 0.07 MPa (7m head). The reinforced cement
concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

22.7.2 Concrete used for the manufacture of un-reinforced and reinforced concrete pipes and collars shall not be leaner than M15 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm, the maximum size of aggregate should be 10mm. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

22.7.3 The dimensional requirement of concrete pipes are given in Table 22.3 & 22.4.

22.7.3.1 DIMENSIONAL REQUIREMENT OF CLASS NP2-REINFORCED CONCRETE LIGHT DUTY, NON PRESSURE PIPES & COLLAR

**TABLE 22.3**

<table>
<thead>
<tr>
<th>Nominal Internal Diameter of Pipe mm</th>
<th>Barrel Wall Thickness of Pipe mm</th>
<th>Collar Dimensions</th>
<th>Reinforcements in Collar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum Caulking space mm</td>
<td>Minimum Thickness mm</td>
</tr>
<tr>
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<tr>
<td>80</td>
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<td>50</td>
<td>19</td>
<td>40</td>
</tr>
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<td>Nominal Internal Diameter of Pipe</td>
<td>Barrel Wall Thickness of pipe</td>
<td>Collar Dimensions</td>
<td>Reinforcements in Collar</td>
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<tr>
<td>----------------------------------</td>
<td>------------------------------</td>
<td>------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum Caulking space</td>
<td>Minimum Thickness</td>
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<td>mm</td>
<td>mm</td>
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<td>mm</td>
</tr>
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<td>2200</td>
<td>110</td>
<td>19</td>
<td>110</td>
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</tbody>
</table>

**Note:**

1. If the mild steel is used for spiral reinforcement, the weight specified under col. 7 shall be increased by a factor 140/25.

2. Soft grade mild steel wire may be used as reinforcement for collars of pipes of nominal internal diameter up to 250 mm only, by increasing the weight by a factor 140/84. Where only soft grade mild steel wire is used for making collar cages, the weight of reinforcement shall be total weight or col. 6 and 7 multiplied by 140/84. This is allowed as a process requirement.

3. Internal diameter of collar to suit the actual diameter of pipe with minimum caulking space as given in col. 2

### 22.7.3.2 REINFORCED CONCRETE PRESSURE PIPES CLASS P1 TESTED TO 20m HEAD, CLASS P2 TESTED TO 40 m HEAD AND CLASS P3 TESTED TO 60m HEAD

<table>
<thead>
<tr>
<th>Internal diameter of pipes (mm)</th>
<th>Class P1 (mm)</th>
<th>Class P2 (mm)</th>
<th>Class P3 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>100</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>225</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>250</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>300</td>
<td>30</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Internal diameter of pipes (mm)</td>
<td>Barrel dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class P1 (mm)</td>
<td>Class P2 (mm)</td>
<td>Class P3 (mm)</td>
</tr>
<tr>
<td>350</td>
<td>32</td>
<td>45</td>
<td>55</td>
</tr>
<tr>
<td>400</td>
<td>32</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>450</td>
<td>35</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>500</td>
<td>35</td>
<td>55</td>
<td>75</td>
</tr>
<tr>
<td>600</td>
<td>40</td>
<td>65</td>
<td>90</td>
</tr>
<tr>
<td>700</td>
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<td>70</td>
<td>105</td>
</tr>
<tr>
<td>800</td>
<td>45</td>
<td>80</td>
<td>120</td>
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<tr>
<td>900</td>
<td>50</td>
<td>90</td>
<td>-</td>
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<tr>
<td>1000</td>
<td>55</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>1100</td>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1200</td>
<td>65</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Note:**

1. The effective length of barrel shall be 2 m upto 250 mm nominal diameter pipes and 2.5, 3.0, 3.5 or 4.0 m for pipes above 250 mm.
2. Collar dimensions, will be same as specified for class NP2 pipes.

22.7.4 The minimum clear cover for reinforcement in pipes and collars shall be as given in Table 22.5.

**TABLE 22.5**

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Precast concrete pipe/collar</th>
<th>Minimum clear cover, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Barrel wall thickness</td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Up to and including 75 mm</td>
<td>8</td>
</tr>
<tr>
<td>(b)</td>
<td>Over 75 mm</td>
<td>15</td>
</tr>
<tr>
<td>(ii)</td>
<td>At spigot steps</td>
<td>5</td>
</tr>
<tr>
<td>(iii)</td>
<td>At end of longitudinal</td>
<td>5</td>
</tr>
</tbody>
</table>

**22.8 Laying and Jointing Cement Concrete Pipes and Specials**

**22.8.1 Trenches:** Specification given in IS code 783:1959 shall be followed.

**22.8.2** Where the pipes are to be bedded directly on soil, the bend shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.
22.8.3 Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.

22.8.4 If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

22.8.5 In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipes shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

22.8.6 In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia of the pipes subject to the min. of 10 cm and a maximum of 30cm. The concrete shall extend up the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and above in dia. The pipe shall be laid in this concrete bedding before the concrete has set.

22.8.7 Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe of the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under & around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

22.8.8 When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated, replaced with an equalizing bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.

22.8.9 When the pipes are laid completely above the ground the foundation shall be made even and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe.

22.8.10 The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in the centre of the span.
22.8.11 Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

22.8.12 **Jointing**: Joints are generally of rigid type. Where specified flexible type joints may also be provided where required.

22.8.12.1 Rigid Spigot and Socket Joint: The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool. After a day’s work any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

22.8.12.2 Rigid Collar Joint: The two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) which shall be rammed with caulking tool. After a day’s work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

22.8.12.3 Semi Flexible Spigot and Socket Joint: The joint is composed of specially shaped spigot and socket ends on the concrete pipes. A rubber ring shall be placed on the spigot which shall be forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and the socket, stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After day’s work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

22.8.12.4 Semi Flexible Collar Joint: This is made up of a loose collar which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. Stiff mixture of cement mortar 1:2 (1 cement : 2 fine sand), shall then be filled into the remaining annular space and rammed with a caulking tool. After day’s work, any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

22.8.13 In all pressure pipe lines the recess at the end of the pipe line shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

The number of pipes that shall be jacked together at a time shall depend on the diameter of the pipes and the bearing capacity of the soil, for small pipes up to 25 cm diameter, six pipes can be jacked together at a time.

The quantity of jute and bitumen in the ring shall be just sufficient to fill the recess in the pipe when pressed hard by jacking or by any other suitable
method. Before and during jacking care shall be taken to see that there is no offset at the joint.

22.8.14 Testing : For pressure pipes, the completed pipeline shall be tested for pressure (Known as site test pressure) which shall not be less than the maximum pipeline operating pressure plus the calculated surge pressure, but in no case shall it exceed the hydrostatic test pressure. For non-pressure pipes the joints shall be tested as per procedure laid down under Para 22.2.1.2 (iv).

22.8.15 Refilling of Trenches : The specification described in 22.2.1.2 (v) shall apply. In case where pipes are not bedded on concrete special care shall be taken in refilling, trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe and rammed with a shovel and light tamper. This method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe and continued up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping shall be done within 15 cm of the top of pipe. The tamping shall become progressively heavier as the depth of the backfill increases.

22.8.16 Measurements : The lengths of pipes shall be measured in running meters nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, collars, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

22.8.17 Rate : The rate shall include the cost of materials and labour involved in all the operations described above.

22.9. Cast Iron (Centrifugally Cast) Pipes and Specials

Cast iron (centrifugally cast) pipes and specials shall conform to the specification described in Chapter 1, Chapter 2 & Chapter 3.

22.10 Road Gully Grating

22.10.1 Horizontal Gully Grating :

The gully grating cover shall be hinged to the frame to facilitate its opening for cleaning and repairs. The weight of grating shall be minimum 75 Kg. In case of R.C.C. horizontal gully grating it shall be in cement concrete 1:1:2 (1 cement : 1 coarse sand : 2 graded stone aggregate 20mm nominal size).

22.10.2 Vertical Gully Grating :-

The chamber shall be of brick masonry, 12 mm dia, round bar shall be fixed in cement concrete block at the bottom. The bars at the top shall be welded or riveted to M.S. flat 40x6 mm.
22.10.3 Horizontal and Vertical Gully Grating:
The details of typical road gully chamber of brick masonry with horizontal and vertical grating.

22.11 MANHOLE COVERS & FRAMES

22.11.1 Manhole Covers

The covers and frames shall conform to IS 1726 for cast iron and IS 12592 for pre-cast concrete covers and shall be of the following grades and types.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Grade Designation</th>
<th>Type/shape of cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Duty</td>
<td>LD - 2.5</td>
<td>Rectangular, Square, Circular</td>
</tr>
<tr>
<td>Medium Duty</td>
<td>MD- 10</td>
<td>Rectangular, Circular and Square (for pre-cast concrete manhole covers)</td>
</tr>
<tr>
<td>Heavy Duty</td>
<td>HD - 20</td>
<td>Circular - Square, Rectangular (Scraper Manhole)</td>
</tr>
<tr>
<td>Extra Heavy Duty</td>
<td>EHD- 35</td>
<td>Circular, Square, Rectangular (Scraper Manhole)</td>
</tr>
</tbody>
</table>

22.11.2 Cast Iron Manhole Covers and Frames

22.11.2.1 Manhole covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG 150 grade of IS 210.

22.11.2.3 They shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping.

22.11.2.4 Covers shall have on its operative top a raised chequered design to provide for an adequate no-slip grip. The rise of chequres shall be not less than 4 mm.

22.11.2.5 Key holes, Keys and lifting devices shall be provided in the manhole covered to facilitate their placement in the frames and their operative maintenance.

22.11.2.6 Manhole covers and frames shall be coated with material having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.

22.11.2.7 The approximate weight, size, shape & performance requirement of the various type of manhole covers and frames shall be as per IS 1726.

22.11.2.8 The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

22.11.2.9 Marking : Each manhole covers and frame shall have cast on them the following information:
22.11.2.9.1 Manufacturer’s name or trade-mark.
22.11.2.9.2 Grade designation
22.11.2.9.3 Date of manufacturer
22.11.2.9.4 The words SWD or ‘Sewer’ to denote ‘storm water drain’ or ‘sewer’ respectively.
22.11.2.9.5 Identification marks as required by Engineer-in-Charge.
22.11.2.10 The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
22.11.2.11. The cover shall be gas tight and water tight.

22.11.3 Pre-Cast Concrete Manhole Covers & Frames

22.11.3.1 Pre-cast reinforced cement concrete manhole covers intended for use in sewerage and water works shall generally conform to IS 12592.

22.11.3.2 Shapes and Dimensions:

Shape, dimensions and tolerance of pre-cast concrete manhole covers and frames shall conform to IS 12592. Outside dimension of cover at top shall match with corresponding frame so that the maximum clearance at top between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and covers, is in level within a tolerance of ± 5 mm.

For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover.

22.11.3.3 Lifting Device :

The minimum diameter of mild steel rod used as lifting device shall be 12 mm for light and medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot galvanising or epoxy coating or any other suitable treatment.

22.11.3.4 Finishing & Coating :

To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish.

In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating. To prevent the top outer edge of frame from possible damages, it shall be protected by 25 mm X 3 mm mild steel flat as part of the frame.

22.11.3.5 Physical Requirements

22.11.3.5.1 General: All units shall be sound and free from cracks and other defects with interface with the proper placing of the unit or impair the strength of
performance of the units. Minor chipping at the edge/surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.

22.11.3.5.2 Load Test: The breaking load of individual units when tested in accordance with the method described in IS 12592 shall be not less than the values specified in Table 22.6.

<table>
<thead>
<tr>
<th>Grade of Cover</th>
<th>Type</th>
<th>Load in Tones</th>
<th>Diameter of Blocks in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHD - 35</td>
<td>Circular, Square or Rectangular</td>
<td>35</td>
<td>300</td>
</tr>
<tr>
<td>HD - 20</td>
<td>Circular, Square or Rectangular</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>MD - 10</td>
<td>Circular or Rectangular</td>
<td>10</td>
<td>300</td>
</tr>
<tr>
<td>LD - 2.5</td>
<td>Rectangular, Square or Circular</td>
<td>2.5</td>
<td>300</td>
</tr>
</tbody>
</table>

22.11.3.6 Fixing:
The frames of manholes shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry which shall be paid as extra unless specified otherwise.

22.11.3.7 Measurement:
The manhole covers shall be enumerated under relevant items.

22.11.3.8 Rates:
The rate shall include the cost of materials and labour involved in all the operation described above except fixing of frames and covers which shall be paid as extra unless specified otherwise in the item.

22.11.4 Foot Rest:
Foot rests shall be of 20 mm M.S. square or round bars as specified.

22.12 MANHOLES
22.12.1 At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 m.

22.12.2 Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer-in-Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.
22.12.3 Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

22.12.4 Sewers of unequal sectional area shall not be jointed at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

22.12.5 No drain from house fittings, e.g. gully trap or soil pipe, etc to manhole shall normally exceed a length of 6 m unless it is unavoidable.

22.12.6 Manholes 90 x 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m X 90 cm are generally constructed for main drainage work for depths less than 1.5m.

22.12.7 Manhole 1.4 m x 90 cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

22.12.8 Manholes 0.91m, 1.52m or 1.22m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450mm in the same manner as in the case of rectangular manholes.

22.12.9 Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. When manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

22.12.10 Excavation

The excavation for manholes shall be true to dimensions and levels shown on the plans or as directed by the Engineer-in-Charge.

22.12.11 Bed Concrete

The manholes shall be built on a bed of cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) unless required by Engineer-in-Charge. The thickness of the bed concrete shall be 20 cm for manholes upto 4.25 m depth and 30 cm for depths beyond 4.25 m unless otherwise specified or directed by the Engineer-in-Charge. In bad ground, special foundations as suitable shall be provided.

22.12.12 Brick Work
22.12.1 The brick work shall be with class 40 bricks in cement mortar 1:4 (1 cement: 4 coarse sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. For arched type and circular manholes, brick masonry in arches and arching over the pipes shall be in cement mortar 1:3 (1 cement: 3 fine sand). In the case of manholes of circular type the excess shaft shall be corbelled inwardly on three sides at the top to reduce its size to the cover frame to be fitted.

22.12.2 The walls such be built of one brick thickness for depths up to 4.25 m. Below a depth of 4.25m in ordinary subsoil the wall thickness shall be increased to one and half brick and at 9.75 m below ground two brick thick walls shall be built.

22.12.13 Plaster and Pointing

22.12.13.1 The walls of the manholes shall be plastered inside with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth. In the case of arched type manhole the walls of the manhole shall be plastered inside all-round only up to the crown level, and flush pointed for the shaft with cement mortar 1:2 (1 cement : 2 fine sand). Where the saturated soil is met with, also the external surface of the walls of the manhole shall be plastered with 12 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished smooth up to 30 cm above the highest sub-soil water level with the approval of the Engineer-in-Charge. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer’s specifications.

22.12.13.2 For earth work excavation, bed concrete brick work, plaster and pointing, R.C.C. work and refilling of earth, respective specifications shall be followed.

22.12.14 Benching

The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The depth of channels and benching shall be as given in Table 22.7.

22.12.15 Foot Rests

22.12.15.1 All manholes deeper than 0.8m shall be provided with M.S. foot rest. These shall be embedded 20 cm deep in 20 x 20x 10 cm blocks of cement concrete 1:3:6 (1 cement : 3 coarse sand 6 graded stone aggregate 20 mm nominal size). The concrete block with M.S. foot rest placed in its centre shall be cast in situ along with the masonry and surface finished with 12 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished smooth.

### TABLE 22.7

<table>
<thead>
<tr>
<th>Sizes of drain mm</th>
<th>Top of channel at the centre above bed concrete cm</th>
<th>Depth of benching at side walls above bed concrete cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>150</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>200</td>
<td>25</td>
<td>35</td>
</tr>
</tbody>
</table>
22.12.15.2 Foot rests which shall be of 20 x 20 M.S. bars shall be fixed 40 cm apart vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top foot rest shall be 45 cm below the manhole cover.

22.12.15.3 Foot rests shall be painted with coal tar, the portion embedded in the cement concrete block being painted with thick cement slurry before fixing.

22.12.16 **Manhole Covers and Frames**

The frame of manholes shall be firmly embedded to correct alignment and levels in R.C.C. slab or plain concrete as the case may be on the top of the masonry. After completion of the work, manhole covers shall be sealed by means of thick grease.

22.12.17 **Measurement**

Manholes shall be enumerated under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

22.12.18 **Rate**

22.12.18.1 The rate shall include the cost of materials and labour involved in all the operations described above but excludes the cost of (i) excavation, (ii) M.S. foot rest and (iii) 12 mm thick cement plaster with waterproofing material applied at the external surfaces of the manhole if required. These items shall be paid for separately under relevant items of work.

22.12.18.2 Payment for extra depths of manholes shall be made separately under relevant items of work.

22.13 **DROP CONNECTION**

22.13.1 In cases where branch pipe sewer enters the manhole of main pipe sewer at a higher level than the main sewer, a drop connection shall be provided. The work shall be carried out S.C.I. pipes and special conforming to IS 1729 shall be of the same size as that of the branch pipe sewer.

22.13.2 For 150 and 250 mm main line, if the difference in level between the water line (peak flow level) and the invert level of the branch line is less than 60 cm, a drop connection may be provided with in the manhole by giving suitable ramp. If the difference in level is more than 60 cm, the drop shall be provided externally.
22.13.3 The main lines up to 350mm dia, are designed for half depth of flow, from 350 mm to 900 mm for 2/3 depth of flow and beyond 900 mm for 3/4 depth of flow.

22.13.4 **Excavation**

22.13.4.1 The excavation shall be done for the drop connection at the place where the branch line meets the manhole. The excavation shall be carried up to the bed concrete of the manhole and to the full width of the branch line.

22.13.5 **Laying**

22.13.5.1 At the end of branch sewer line S.C.I. cross shall be fixed to the line which shall be extended through the wall of the manhole by a horizontal piece of S.C.I. pipe to form an inspection or cleaning eye. The open end shall be provided with chain and lid. The S.C.I. drop pipe shall be connected to the cross at the top and to the S.C.I. bend at the bottom. The bend shall be extended through the wall of the manhole by a piece of C.I. pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and finished smooth to connect the main channel. The joint between S.C.I. pipe and fittings shall be lead caulked. The joint between S.C.I. cross and S.W. branch line shall be made with cement mortar 1:1 (1cement: 1 fine sand).

22.13.5.2 The exposed portion of the drop connection shall be encased all-around with minimum 15 cm thick concrete 1:5:10 (1cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) and cured. For encasing the concrete around the drop connection, the necessary centering and shuttering shall be provided. The holes made in the walls of the manhole shall be made good with brick work in cement mortar 1:4 (1cement: 4 coarse sand) and plastered with cement mortar 1:3 (1 cement: 3 coarse sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level.

22.13.6 **Measurement**

Drop connection shall be enumerated. The depths beyond 60 cm shall be measured in running metres correct to a cm under relevant items.

22.13.7 **Rate**

The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of excavations and refilling.

22.14 **OPEN SURFACE DRAIN**

22.14.1 The open drains shall be of the size, as specified in the size, as specified in the item and laid to such gradients and in such locations as may be shown in the relevant drawing or as directed by the Engineer-in-Charge.

22.14.2 The size of the drain as specified shall be the width of the drain at the top, measured between the masonry walls. The drain shall be given, as far as possible, uniform slope from the starting point to the discharge point.
22.14.3 The average depths of the various sizes of drains shall be as follows:

<table>
<thead>
<tr>
<th>Drain Size</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td>15 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td>25 cm</td>
<td>30 cm</td>
</tr>
</tbody>
</table>

Table No.- 22.8

22.14.4 Measurement

The drains shall be measured in running metres, correct to a cm.

22.14.5 Rate

The rate shall include the cost of labour and material required for all the operations described above, suitable deduction or extra payment, per cm basis shall be made in case there is a variation in average depths from those stated above.

22.15 Road gully chamber with grating

22.15.1 Road Gully Chamber with Horizontal Grating

The chamber shall be of brick masonry of specified class and shall have a C.I. grating with frame fixed in 15 cm thick cement concrete 1:2:4 (1 cement : 2 coarse sand: graded stone aggregate 20 mm nominal size) at the top. The size of the chamber shall be taken as the clear internal dimensions of the C.I. frame. The chamber shall have a connection pipe, the length of which in metre between the road gully chamber and the manhole of the drain shall not be less than one by forty (1/40) times the nominal diameter of pipe in mm (i.e. for 150 mm connection pipe, length shall not be less than 3.7 m and for 250 mm connection pipe length shall not be less than 6.25 m). The chamber shall be built at the location fixed by the Engineer-in-Charge. Generally the spacing of the chambers shall be 18 to 36 m depending upon the grading of the road channel and the area of the drainage. R.C.C. gully grating shall be fixed in cement mortar 1:2 (1 cement : 2 coarse sand).

22.15.2 Road Gully Chamber with Vertical Grating

The chamber shall be of brick masonry 12 mm dia round bar shall be fixed in cement concrete block at the bottom. The bars at the top shall be welded or riveted to M.S. flat 40 x 6 mm. The specifications shall be same as described in 22.7.1.

22.15.3 Road Gully Chamber with Horizontal and Vertical Grating

The details of typical road gully chamber of brick masonry shall be same.

22.15.4 Measurement

Road gully chambers shall be enumerated.

22.15.5 Rate
The rate shall include the cost of materials and labour involved in all the operations described above except the cost of excavation and connection pipes.

22.16 Brick masonry gully trap

22.16.1 The internal size of the trap shall be 80 x 40 x 46 cm. The height shall be measured from the top of the floor to the top of the cover. 40 mm thick stone baffles shall be fixed 50 mm deep in masonry with cement mortar 1:4 (1 cement : 4 fine sand), as shown in the Fig. 11. The connection of open surface, drain with a soak pit shall be invariably through a grease trap.

22.16.2 Measurements

Grease traps shall be enumerated.

22.16.3 Rate

The rate shall include the cost of labour and materials required for all the operations described above.

22.17 SEPTIC TANK

22.17.1 In unsewered area, every house shall have arrangement for its sewage being treated in septic tank, effluent from which should be given secondary treatment either in a biological filter or on the land, or in a sub-surface disposal system.

22.17.2 Surface and sub-soil water should be excluded from finding way into the septic tank. Waste water may be passed into the septic tank provided the tank and the means for effluent disposal are designed to cope up with this extra liquid. Depending on the location of the water table and the nature of the strata, the type of disposal for the effluent from the septic tank shall be decided.

22.17.3 Dimensions

22.17.3.1 Septic tanks shall have minimum width of 75 cm, minimum depth of one meter below water level and a minimum liquid capacity of the one cubic meter. Length of tanks shall be 2 to 4 times the width. Suitable sizes of septic tanks for use of 5, 10, 15, 20 and 50 persons based on certain assumptions are given in table 22.9, 22.10, 22.11.

22.17.3.2 RECOMMENDED SIZES OF SEPTIC TANKS FOR 5-20 USERS

<table>
<thead>
<tr>
<th>No. of users</th>
<th>Length m</th>
<th>Breadth m</th>
<th>Liquid depth (Cleaning interval of 1 year) m</th>
<th>2 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>1.5</td>
<td>0.75</td>
<td>1.0</td>
<td>1.05</td>
</tr>
<tr>
<td>10</td>
<td>2.0</td>
<td>0.90</td>
<td>1.0</td>
<td>1.40</td>
</tr>
<tr>
<td>15</td>
<td>2.0</td>
<td>0.90</td>
<td>1.3</td>
<td>2.00</td>
</tr>
<tr>
<td>20</td>
<td>2.3</td>
<td>1.10</td>
<td>1.3</td>
<td>1.80</td>
</tr>
</tbody>
</table>

Notes:
1. The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank.
2. A provisions of 300 mm should be made for free board.
3. The sizes of septic tanks are based on certain assumptions, while choosing the size of septic tank exact calculation shall be made.

### 22.17.3.3 RECOMMENDED SIZES OF SEPTIC TANKS FOR RESIDENTIAL COLONIES

<table>
<thead>
<tr>
<th>No. of users</th>
<th>Length m</th>
<th>Breadth m</th>
<th>Liquid depth (Cleaning interval of)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 year m</td>
</tr>
<tr>
<td>050</td>
<td>05.0</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>100</td>
<td>07.5</td>
<td>2.65</td>
<td>1.0</td>
</tr>
<tr>
<td>150</td>
<td>10.0</td>
<td>3.0</td>
<td>1.0</td>
</tr>
<tr>
<td>200</td>
<td>12.0</td>
<td>3.3</td>
<td>1.0</td>
</tr>
<tr>
<td>300</td>
<td>15.0</td>
<td>4.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Notes:**
1. A provisions of 300 mm should be made for free board.
2. The sizes of the septic tank are based on certain assumptions while choosing the size of septic tank, exact calculation shall be made.
3. For population over 100, the tank may be divided into independent parallel chambers for ease of maintenance and cleaning.

### 22.17.3.4 RECOMMENDED SIZES OF SEPTIC TANKS FOR HOSTEL AND BOARDING SCHOOLS

<table>
<thead>
<tr>
<th>No. of users</th>
<th>Length m</th>
<th>Breadth M</th>
<th>Liquid depth (D) for stated Intervals of sludge withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Once in a year m</td>
</tr>
<tr>
<td>50</td>
<td>5.0</td>
<td>1.6</td>
<td>1.3</td>
</tr>
<tr>
<td>100</td>
<td>5.7</td>
<td>2.1</td>
<td>1.4</td>
</tr>
<tr>
<td>150</td>
<td>7.7</td>
<td>2.4</td>
<td>1.4</td>
</tr>
<tr>
<td>200</td>
<td>8.9</td>
<td>2.7</td>
<td>1.4</td>
</tr>
<tr>
<td>300</td>
<td>10.7</td>
<td>3.3</td>
<td>1.4</td>
</tr>
</tbody>
</table>

**Notes:**
1. A provisions of 300 mm should be made for free board.
2. The sizes of the septic tank are based on certain assumptions while choosing the size of septic tank, exact calculation shall be made.
3. For population over 100, the tank may be divided into independent parallel chambers for ease of maintenance and cleaning.
22.17.4 Cover and Frame

Every septic tank shall be provided with C.I. cover of adequate strength. The cover and frames shall be 500 mm dia (M.D.) minimum or 610 mm x 455 mm (LD). The specification for frames and cover given in 22.3.1 shall apply.

22.17.5 Ventilating Pipe

Every septic tank shall be provided with C.I. ventilating pipe of at least 50 mm diameter. The top of the pipe shall be provided with a suitable cage of mosquito proof wire mesh.

The ventilating pipe shall extend to a height which would cause no smell nuisance to any building in the area. Generally the ventilating pipe may extend to a height of about 2 m, when the septic tank is at least 15 m away from the nearest building and to a height of 2 m. above the top of the building when it is located closer than 15 metres. The ventilating pipe may also be connected to the normal soil ventilating system of the building where so desired.

22.17.6 Disposal of Sludge.

The sludge from septic tanks may be delivered into covered pit or into a suitable vehicle for removal from the site. Spreading of sludge on the ground in the vicinity shall not be allowed.

22.18.7 Testing

Before the tank is commissioned for use, it shall be tested for water-tightness by filling it with water and allowing it to stand for 24 hours. It shall then be topped up, if necessary, and allowed to stand for a further period of 24 hours during which time the fall in the level of the water shall not be more than 1.5 cm.

22.18.8 Commissioning of Septic Tank

The tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall, preferably, be seeded with small quantities of well digested sludge obtained from septic tanks or sludge digestion tanks. In the absence of digested sludge a small quantity of decaying organic matter, such as digested cow-dung, may be introduced.

22.18.9 Sub-Surface Absorption System

The effluent from septic tank shall be disposed of by soak pit or dispersion trench depending on the position of the sub-soil water level, soil and sub-soil conditions and the size of the installation.

22.18.10 Measurements

Septic tank shall be enumerated.

22.18.11 Rate
The rate shall include the cost of materials and labour involved in all the operation, except sub-Surface absorption system which shall be paid for separately.

22.18  SOAK PITS 2.5 M DIA X 3 M DEEP

22.18.1  Construction

The earth excavation shall be carried out to the exact dimensions as shown in the figure. In the soak pit shall be constructed a honey-comb dry brick shaft 45 x 45 cm and 292.5 cm high. Round the shaft and within the radius of 60 cm shall be placed well burnt brick bats. Brick ballast of size from 50 to 80 mm nominal size shall be packed round the brick bats up to the radius of 90 cm. The remaining portion shall be filled with brick ballast of 40 mm nominal size. The construction of shaft and filling of the bats and the ballast shall progress simultaneously.

22.18.2  Cover and Drain

Over the filling shall be placed single matting which shall be covered with minimum layer of 7.5 cm earth. The shaft shall be covered with 7.5 cm thick stone or R.C.C. slab 10cm wide and 10 cm deep brick edging with bricks of class designation 40 shall be provided round the pit. The connection of the open surface drain to the soak pit shall be made by means of 100 mm diameter S.W. pipe with open joints.

22.18.3  Measurements

Soak pit shall be enumerated.

22.18.4  Rate

Rate shall include the cost of labour and material involved in all the operation described above.

22.19  SOAK PIT 1.2 x 1.2 x 1.2 M

22.19.1  Construction

The earth excavation shall conform to the general specification for earth work. After the excavation is complete the soak pit shall be filled with brick bats. The brick bats shall be from properly burnt bricks. 10 cm wide and 10 cm deep brick edging with bricks of class designation 75 shall be provided round the soak pit.

22.19.2  Measurements

Soak pits shall be enumerated.

22.19.3  Rate

Rate shall include the cost of labour and materials involved in all the operations.

22.20  DISPERSION TRENCH
It shall be provided when the sub-soil water level is within 180 cm from the ground level. Dispersion trenches are not recommended in areas where fibrous roots of trees or vegetation are likely to penetrate the system and cause blockages.

22.20.1 Construction

Dispersion trenches shall be 50 to 100 cm deep and 30 to 100 cm wide, excavated to a slight gradient and shall be provided with 15 to 25 cm of washed gravel or crushed stones. Open jointed pipes placed inside the trench shall be made of unglazed earthenware clay or concrete and shall have minimum internal diameter of 75 to 100 mm. Each dispersion trench should not be longer than 30 m and trenches should not be placed closer than 1.8 m.

The covering for the pipes on the top shall be with coarse aggregate of uniform size to a depth of approximately 15 cm. The aggregate above this level may be graded with aggregates 12 to 15 mm to prevent ingress of top soil while the free flow of water is no way retarded. The trench may be covered with about 30 cm of ordinary soil to form a mound and turned over. The finished top surface may be kept at least 15 cm above ground level to prevent direct flooding of the trench during rains.

22.20.2 Measurements

The length of dispersion trench shall be measured in running metres nearest to a cm.

22.20.3 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

22.21 DESLUDGING OF SEPTIC TANKS

Septic tank shall be desludged periodically, the intervals of desludging, depending up to the design of the septic tanks and the capacity in relation to its users. Desludging may be done when the sludge level reaches a predetermined level. A portion of the sludge may be left in the tank to seed the fresh deposits.

Desludging shall preferably be carried out by hydrostatic head or by using a portable pump. Manual handling of sludge shall be discouraged.
GULLY TRAP

Fig. 1 Gully Trap
**Fig. 2 Manhole (Contd.)**

<table>
<thead>
<tr>
<th>Dia Manhole</th>
<th>H1</th>
<th>H2</th>
<th>H3</th>
<th>H4</th>
<th>H5</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>Bed Conc. dc</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>900</td>
<td>750</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 Bk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>226</td>
</tr>
<tr>
<td>1200</td>
<td>1350</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 Bk</td>
<td></td>
<td>1 Bk</td>
<td></td>
<td></td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>1500</td>
<td>1950</td>
<td>750</td>
<td>2100</td>
<td>4050</td>
<td></td>
<td>1 Bk</td>
<td>½ Bk</td>
<td>2 Bk</td>
<td>2½ Bk</td>
<td>3 Bk</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>1800</td>
<td>1950</td>
<td>750</td>
<td>2250</td>
<td>4050</td>
<td></td>
<td>1 Bk</td>
<td>½ Bk</td>
<td>2 Bk</td>
<td>2½ Bk</td>
<td>3 Bk</td>
<td></td>
<td>300</td>
</tr>
</tbody>
</table>

**Notes:**
- H - Height of wall
- T - Thickness of Wall
- D - Dia of Manhole
- d - Dia of Pipe
- dc - Depth of Bed Conc.

The soling will be provided where the site engineer will feel necessary.
MANHOLE
(With Drop Connections)

SECTION AA

SACTION BB

PLAN

DETAIL OF BENCHING

M.S. FOOT REST

Fig. 3: Manhole (With Drop Connections)

Drawing Note: Scale
All Dimensions are in mm
BRICK MASONRY OPEN SURFACE DRAINS

Fig. : Brick Masonry Open Surface Drains
SOAK PIT

SECTION AB

PLAN

Fig. 5: Soak Pit

Drawing Not to Scale
All Dimensions are in mm
23. SANATARY INSTALLATIONS
<table>
<thead>
<tr>
<th>Clause No.</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
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<td>23.2</td>
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<tr>
<td>23.3</td>
<td>Vitreous Chine Cisterns</td>
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<td>23.4</td>
<td>Over Flow Pipe</td>
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<td>23.5</td>
<td>Inlet and Overflow Holes</td>
</tr>
<tr>
<td>23.6</td>
<td>PVC Cisterns</td>
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<td>23.7</td>
<td>Flush Pipe Connection to Cistern</td>
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<tr>
<td>23.8</td>
<td>Inlet and Overflow Holes</td>
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<td>Operating Mechanism Lever</td>
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<td>Overflow Pipe</td>
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<tr>
<td>23.13</td>
<td>Finish</td>
</tr>
<tr>
<td>23.14</td>
<td>Operational and Performance Requirements</td>
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<td>23.15</td>
<td>Special Requirements</td>
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<td>23.16</td>
<td>Draining Board</td>
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<td>Foot Rests</td>
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<td>Glass Shelf/PVC Shelf</td>
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<td>Mirror</td>
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<td>23.20</td>
<td>M.S. Stays and Clamps</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>23.21</td>
<td>Pillar Taps</td>
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<tr>
<td>23.22</td>
<td>Sand Cast Iron or Centrifugally Cast (Spun) Iron Pipes and Fittings</td>
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<td>Sand Cast Iron Floor Trap or Nahani Trap</td>
</tr>
<tr>
<td>23.24</td>
<td>Strength</td>
</tr>
<tr>
<td>23.25</td>
<td>Sinks</td>
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<td>23.26</td>
<td>Towel Rail</td>
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<td>Toilet Paper Holder</td>
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<td>23.28</td>
<td>Urinals</td>
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<tr>
<td>23.29</td>
<td>Half Stall Urinals</td>
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<td>23.30</td>
<td>Urinal Partition Slabs</td>
</tr>
<tr>
<td>23.31</td>
<td>Squatting Plate Urinal</td>
</tr>
<tr>
<td>23.32</td>
<td>Wash Basins</td>
</tr>
<tr>
<td>23.33</td>
<td>Waste Fittings for Wash Basins and Sinks</td>
</tr>
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<td>23.34</td>
<td>Water Closet</td>
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<td>23.35</td>
<td>Squatting Pans (Indian Type W.C.)</td>
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<td>23.36</td>
<td>Long pattern-conforming to IS 2556 (Part-3)</td>
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<td>Wash Down Type (European Type W.C.)</td>
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<td>23.38</td>
<td>GENERAL REQUIREMENTS FOR INSTALLATION OF W.C. PAN</td>
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<td>23.39</td>
<td>INSTALLATION OF DRAINING BOARD</td>
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<tr>
<td>23.40</td>
<td>INSTALLATION OF FLUSHING CISTERN</td>
</tr>
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<td>23.41</td>
<td>Installation of mirror</td>
</tr>
<tr>
<td>23.42</td>
<td>FIXING AND JOINTING OF PIPES AND FITTINGS</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>23.43</td>
<td>INSTALLATION OF SEAT AND COVER TO WATER CLOSET</td>
</tr>
<tr>
<td>23.44</td>
<td>INSTALLATION OF SINK</td>
</tr>
<tr>
<td>23.45</td>
<td>INSTALLATION OF URINAL LIPPED, HALF STALL (SINGLE OR RANGE)</td>
</tr>
<tr>
<td>23.46</td>
<td>INSTALLATION OF STALL URINAL (SINGLE OR RANGE)</td>
</tr>
<tr>
<td>23.47</td>
<td>Installation of wash basin</td>
</tr>
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<td>23.48</td>
<td>Installation of squatting pan</td>
</tr>
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<td>23.49</td>
<td>Installation of water closet</td>
</tr>
<tr>
<td>23.50</td>
<td>INSTALLATION OF FOOT RESTS</td>
</tr>
<tr>
<td>23.51</td>
<td>INSTALLATION OF SQUATTING PLATE (SINGLE OF RANGE)</td>
</tr>
<tr>
<td>23.52</td>
<td>INSTALLATION OF TOWEL RAIL</td>
</tr>
</tbody>
</table>
23.1 MATERIALS:

23.1.1 All vitreous sanitary appliances (Vitreous China) shall conform to IS 2556 (Part-1).

23.2 Flushing Cisterns

23.2.1 The flushing cisterns shall be automatic or manually operated high level or low level as specified, for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of the pan and the under side of the cistern.

23.2.2 Cisterns shall be of following type (i) Vitreous China (IS 774) for Flushing type (ii) Automatic Flushing Cistern (IS 2326) and (iii) Plastic cisterns (IS 7231).

23.3 Vitreous China Cisterns:

23.3.1 The thickness of the body including cover shall be not less than 6 mm for vitreous China cisterns. The outlet of each siphon or stand pipe shall be securely connected to the cistern by means of lock nut. The cistern shall be free from manufacturing faults and other defects affecting their utility. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito proof. A cistern shall be considered mosquito proof only if there is no clearance anywhere which would permit a 1.6 mm wire to pass through in the permanent position of the cistern i.e. in the flushing position or filling position.

23.3.2 The breadth of a low level cistern, from front to back shall be such that the cover or seat, or both, of water closet pan shall come to rest in a stable position when raised.

23.3.3 The cistern shall be supported on two cast iron brackets of size as approved by the Engineer-in-Charge and embedded in cement concrete 1:2:4 block 100 x 75 x 150 mm. These shall be properly protected by suitable impervious paint. Alternatively the cisterns shall have two holes in the back side above the overflow level for screwing into the wall, supplemented by two cast iron wall supports. A 5 litres cistern, however, may be supported by larger brackets cast on the body of the cistern.

23.3.4 The cistern shall have a removable cover which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern. The nominal internal diameter of cistern outlet shall be not less than 38 ± 1 mm for...
low level cisterns respectively. The length of the outlet of the cistern shall be 37 ± 2 mm.

23.3.5 Ball valve shall be of screwed type 15mm in diameter and shall conform to IS 1703. The float shall be made of polyethylene as specified in IS 9762.

23.3.6 In the case of manually operated cisterns the siphonic action of the flushing cistern shall be capable of being rapidly brought into action by the operating lever, but shall not self siphon or leak.

23.3.7 The cisterns shall be so designed that there is no appreciable variation in the force of lush during the discharge of the required quantity of water. The cistern shall have a discharge capacity of 5 & 10 litres as specified. When required to give a full flush, they shall respectively discharge 5 litres and 10 litres with variation of ± 0.5 litres.

23.3.8 The flush pipe shall be of (a) medium quality galvanized iron having internal diameter of 38 ± 1 mm for low level cistern. The flush pipe shall be of suitable length with bends etc. as required for fixing it with front or back inlet W.C. Pan. (b) Polyethylene pipes low density conforming to IS 3076 or high density (c) Unplasticised PVC pipes. For high density polyethylene and unplasticised PVC pipes, the outside diameter of the pipes shall be 40 mm.

23.3.9 In case of low level cistern the flush pipe shall be a vertical pipe 30 cm long and having a nominal internal dia 38 ± 1 mm (except plastic flush pipes).

23.4 Over Flow Pipe

23.4.1 GI overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non- corrodi ble mosquito proof brass cover having 1.25 mm dia perforation, screwed in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water closet or soil pipe without being detected.

23.4.2 The invert of the overflow pipe in the case of high level and low level cisterns shall be 19 mm minimum above the working water level. In case of overflow due to any reason water should drain out through the over flow pipe and not through the siphon pipe.

23.4.3 The plastic overflow pipes shall be manufactured from high density polyethylene conforming to IS 4984 or unplasticised P.V.C. conforming to IS 4985.

23.5 Inlet and Overflow Holes :

23.5.1 The cistern shall be provided with inlet and overflow holes, situated one at each end which shall be capable of accommodating an overflow pipe of not less than 20 mm nominal bore and a 15 mm size ball valve. The holes shall be cleanly cast or drilled and the adjacent surfaces shall be smooth.

23.6 PVC Cisterns:

23.6.1 Plastic flushing cisterns for WC and Urinals shall be as per IS 7231.
The materials for manufacturing various components of the flushing cisterns shall conform to the requirements given in Table 23.1

### TABLE 23.1
Material for Various Components of Flushing Cisterns

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Component(s)</th>
<th>Material</th>
<th>Conforming to</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>1.</td>
<td>Cisterns</td>
<td>High density polyethylene (HDPE)</td>
<td>IS 7328</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polystryene, high impact</td>
<td>IS 2267</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polypropylene</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acrylonitrile-butadiene-styrene (ABS)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass Fibre reinforced plastic (GRP)</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Flush Pipe</td>
<td>Steel tube, seamless or welded, medium or light, completely protected inside and outside by hot-dip galvanizing, electroplating or vitreous enamelling</td>
<td>IS 1239 (Part 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lead Pipe</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Copper alloy tube</td>
<td>IS 404 (Part 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High density polyethylene pipe</td>
<td>IS 407</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unplasticised PVC plumbing pipe</td>
<td>IS 2501</td>
</tr>
<tr>
<td>3.</td>
<td>Cover</td>
<td>Same material as that of the body</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>Chain</td>
<td>Hot-dip galvanized steel wires</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inter-locked non-ferrous metal</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any other corrosion resistant material</td>
<td>-</td>
</tr>
<tr>
<td>5.</td>
<td>Overflow pipe</td>
<td>High density polyethylene</td>
<td>IS 4984</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unplasticised PVC</td>
<td>IS 4985</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any other corrosion-resistant material</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Siphon/Valve</td>
<td>High density polyethylene</td>
<td>IS 7328</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polystyrene, high impact</td>
<td>IS 2267</td>
</tr>
<tr>
<td>Sl.No.</td>
<td>Component(s)</td>
<td>Material</td>
<td>Conforming to</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polypropylene</td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acrylonitrile-butadiene-styrene</td>
<td>Or</td>
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<tr>
<td></td>
<td></td>
<td>Glass fibre reinforced plastic (GRP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Operating Mechanism/Lever</td>
<td>Non-ferrous metal or any other corrosion-resistant material</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Float valve</td>
<td>As specified in IS 1703</td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS 12234</td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IS 13049</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Polyethylene float for float valve</td>
<td>As specified in IS 9762</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Coupling nut and lock-nut</td>
<td>Non-ferrous metal,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot-dip galvanized steel</td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot-dip galvanized malleable iron</td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any other non-corrosive metal</td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Or</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Injection-moulded HDPE/polyacetal</td>
<td></td>
</tr>
</tbody>
</table>

23.6.3 Talc as filler, if used shall not exceed 20%.

23.6.4 The thickness of the body including cover at any point shall not be less than 2 mm for GRP, and not less than 3 mm for other plastic materials. The cistern shall be free from manufacturing faults and other defects affecting its utility. All working parts shall be designed so as to operate smoothly and efficiently. The cistern shall be mosquito-proof. It shall be deemed to be mosquito proof only when there is no clearance anywhere in it which would permit a 1.6 mm diameter wire to pass through.

23.6.5 The outlet of each siphon or stand pipe of flush valve shall be securely connected to the cistern by means of a lock nut. In the case of plastic siphon, it shall be provided with suitable means of ensuring and maintaining watertight and airtight joint to the cistern.

23.6.6 The cistern shall be provided with a removable cover which shall fit closely and shall be secured against displacement. In designs, where the operating mechanism is attached to the cover, the cover may be made in two sections, the section supporting the mechanism being securely fixed or booked to the body.
The flush pipe (except plastic flush pipe) shall have an internal diameter of \(32 \pm 1\) mm for high level cistern and \(38 \pm 1\) mm for low level cistern. The steel flush pipe shall be not less than 1 mm thick whereas the lead flush pipe shall have a minimum thickness of 3.5 mm. For high density polyethylene pipes, the outside diameter of the pipes shall be 40 mm.

For unplasticised PVC plumbing pipes the outside diameter of the pipe shall be 40 mm for high level cisterns, and 50 mm for low level cisterns. In the case of high level flushing cisterns, a pipe clip fitted with a rubber buffer shall be fixed to the flush pipe to prevent damage either to the pipe or to the seat when the seat is raised. No flush pipe is required for coupled cisterns.

**Flush Pipe Connection to Cistern**

**23.7.1** The flush pipe shall be securely connected to cistern outlet and made airtight by means of a coupling nut. The nuts made of injection-molded HDPE/Polyacetal may be used only if the end pipe is also made of plastic. The nominal internal diameter of the cistern outset shall be not less than 32 mm and 38 mm for high-level and low-level cisterns respectively.

**23.7.2** The screw threads for connection to the flush pipe shall not be less than size 1½ of IS 2643 (Part 3). In the case of polyethylene and unplasticised PVC flush pipes, the upper end of the flush pipe shall be provided with suitable means of ensuring and maintaining a watertight and airtight joint to the flushing cistern. When ordered for use with a flush pipe, the outlet connection may be supplied with coupling nut made of copper based alloy or other non-corrodible material and a plain tall piece having a minimum length of 60 mm.

**23.7.3** The centre of the outlet hole shall be generally central to the length of the cistern. The length of the outlet shall be \(37 \pm 2\) mm in case of interchangeable siphon; however, where integral siphon is provided, the outlet length shall be \(20 \pm 2\) mm.

**Inlet and Overflow Holes**

**23.8.1** The cistern shall be provided with inlet and overflow holes, situated one at each end, which shall be capable of accommodating overflow pipe of not less than 20 mm nominal bore and a 15 mm size float valve. The holes shall be cleanly moulded or drilled and the adjacent surfaces shall be smooth.

**Float Valve**

**23.9.1** The float valve shall be 15mm nominal size and shall conform to IS 1703 or IS 12234 or IS 13049.

**Operating Mechanism Lever**

**23.10.1** The operating mechanism/lever shall not project beyond the side of cistern of a distance greater than 350mm measured from the centre of the cistern to the end of the lever arm. The lever arm shall be provided with a suitable hole near the end through which a split ring or S-hook can be inserted. A string (chain) shall be attached to the ring or hook. When S-hook is employed, it shall be effectively closed after assembly to prevent accidental disconnection.
23.10.2 In the case of low-level cisterns, where the mechanism is handle operated, the handle, whether situated on the front or at the end of the cistern, shall be within the projection limit. Particular attention shall be given to the case of operation of the handle.

23.11 **String (Chain)**
23.11.1 The string (chain) shall be of such strength as to sustain a dead load of 500 N without any apparent or permanent deformation.

23.11.2 The string (chain) shall terminate in a suitable handle or pull made of a moulding in any heat-resisting and non-absorbent plastic or any other equally suitable material. The finish shall be smooth and all burrs which are liable to cause injury to the hand when gripped shall be removed.

23.12 **Overflow Pipe**
23.12.1 The overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non-corrodible mosquito-proof device secured in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water-closet or soil pipe without being detected.

23.12.2 The invert of the overflow pipe in the case of high level and low level cisterns and the top edge of the overflow pipe in the case of coupled cistern shall be 19 mm (Min) above the working water level. In case of overflow due to any reason, water should drain out through the overflow pipe and not through the siphon pipe.

23.13 **Finish**
23.13.1 The surface of the cistern including cover shall be free from blisters and delamination and reasonably free from flow lines, streaking or colour variations. The cistern and cover shall be opaque to light.

23.14 **Operational and Performance Requirements**
23.14.1 **Flushing Arrangement**
23.14.1.1 The cistern under working conditions and with the float valve in closed position shall operate on a single operation of the operating mechanism/lever without calling for a sudden jerk in pulling. If a valve is used instead of siphon for flushing purposes, the valve shall be completely leak proof.

23.14.2 **Working Water Level**
23.14.2.1 The working water-level shall be a minimum of 6.5 cm. below the effective top edge of the cistern and shall be legibly and permanently marked on the inside of the cistern. Effective top edge shall be taken on edge after top of the body without considering bead.

23.14.3 **Freedom from Self Siphonage**
23.14.3.1 The siphonic system shall be capable of being rapidly brought into action when the water is at the working water level, but shall not self siphon or leak into the flush pipe when the water is up to 1 cm above the invert of the overflow pipe.
23.14.4 Reduced Water Level

The discharge shall operate satisfactorily when the cistern is filled to a level up to 1 cm below the working water level.

23.14.5 Discharge Capacity

When tested in accordance with IS 7231, cistern of 5 litres and 10 litres capacities, when required to give a full flush, shall respectively discharge 5 litres and 10 litres with variation of ± 0.5 litres. Dual-flush cistern of 10 litres capacity shall discharge alternatively a short flush of 5 ± 0.5 litres. Dual flush cistern of 6/3 litres capacity shall discharge 6 ± 0.5 litres and alternatively a half flush of 3 ± 0.5 litres.

23.14.6 Discharge Rate

When tested in accordance with IS 7231, the discharge rate shall be 10 ± 0.5 litres within 6 seconds and 5 ± 0.5 litres within 3 seconds for cistern of capacities 10 litres and 5 litres and 6 ± 0.5 litres within 6 seconds and 3 ± 0.5 litres within 3 second for cistern of 6/3 litres capacity respectively.

The cistern shall be so designed that there is no appreciable variation in the force of the flush during the discharge of the required quantity of water. For coupled cisterns, this test shall not be applicable.

23.15 Special Requirements

23.15.1 Distortion Resistance Test

The cisterns, complete with its fittings, shall be installed and filled with water to the marked water line and observed for any distortion. The cistern shall not budge more than 6 mm and the cover shall not be dislodged.

23.15.2 Dead Load Test

When the flushing mechanism incorporates chain pull or hand operated lever, the cistern, complete with its fittings, when installed and filled with water to the marked water line and tested by the application of a dead load of 230 N applied 6 mm from the end of the operating lever arm for 30 seconds, shall not distort to such an extent that any part becomes detached.

In the case of other operating mechanism, the dead load applied shall be a mass equivalent to the operating force required to overcome the normal hydrostatic head; Thirty seconds after the load is removed, the function and appearance of the cistern shall not be impaired.

23.15.3 Front Thrust Test

The front thrust test shall be applied only to cisterns intended for low level use. The cistern complete with its fittings, when installed and filled with water to the marked water line and tested by the method described in IS 7231, shall not distort to such an extent as to be inoperable or unsightly when the load is removed.
23.15.4 Impact Test

23.15.4.1 The cistern, complete with its fittings, when installed and filled as described in IS 7231 shall show no defect after one impact. Repeat the test but with the cistern empty. The cistern shall show no defect after the further impact.

23.16 Draining Board

23.16.1 Draining board made of Glazed fireclay conforming to DUAD Specifications and as per directions of Engineer-in-Charge, shall be provided. The size of the board shall be as specified. The entire surface including bottom of the board shall be finished smooth.

23.17 Foot Rests

23.17.1 Foot rest shall be of Vitreous China conforming to IS 2556 (Part-X). Foot rests which are rectangular shall meet the minimum requirements and dimensions shown in Fig. 30 and may be of different designs where so specified. Foot rests of different shapes and sizes shall also be allowed subject to approval of Engineer-in-Charge.

23.18 Glass Shelf/PVC Shelf

23.18.1 Glass shelf shall consist of an assembly of glass shelf, with anodized aluminium angle frame to support the glass shelf. The shelf shall be of glass of best quality with edges rounded off, and shall be free from flaws specks or bubbles. The size of the shelf shall be 60 x 12 cm unless otherwise specified and thickness not less than 5.5 mm. The shelf shall have C.P. brass brackets which shall be fixed with C.P. brass screws to rawl plugs firmly embedded in the walls.

23.18.2 PVC shelf as per manufacturer’s specifications and size as specified shall be provided.

23.19 Mirror

23.19.1 The mirror shall be of superior glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60x45 cm unless specified otherwise and its thickness shall not be less than 5.5 mm. It shall be uniformly sliver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.

23.19.2 Where beveled edge mirrors of 5.5 mm thickness are not available, fancy looking mirrors with PVC beading/border or aluminium beading or stainless steel beading/border based on manufacturer’s specifications be provided nothing extra shall be paid on this account. Backing of mirrors shall be provided with environmentally friendly material other than asbestos cement sheet.

23.20 M.S. Stays and Clamps

23.20.1 The clamps shall be made from 1.5 mm thick M.S. flat of 32 mm width, bend to the required shape and size to fit tightly on the socket, when tightened with
nuts & bolts. It shall be formed of two semicircular pieces with flanged ends on both sides with holes to fit in the screws, bolts and nuts 40 mm long.

23.20.2 The stay shall be minimum one metre long of 10 mm dia M.S. bar. One end of the stay shall be bend for embedding in the wall in cement concrete block of size 20 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The concrete shall be finished to match with the surrounding surface.

23.21 Pillar Taps

23.21.1 Pillar taps shall be chromium plated brass and shall conform to IS 1795. The nominal sizes of the pillar tap shall be 15 mm or 20 mm as specified. The nominal size shall be designated by the nominal bore of the pipe outlet to which the tap is to be fitted. Finished weights of 15 mm and 20 mm pillar taps shall be as prescribed in Table 23.2

| TABLE 23.2
Minimum Finished Weights of Pillar Taps |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulars</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Body</td>
</tr>
<tr>
<td>Washer plate loose valve</td>
</tr>
<tr>
<td>Back nut</td>
</tr>
<tr>
<td>Tap</td>
</tr>
</tbody>
</table>

23.21.2 Casting shall be sound and free from laps, blow hole and pitting. External and internal surfaces shall be clean, smooth and free from sand and be neatly dressed. The body, bonnet and other parts shall be machined true so that when assembled, the parts shall be axial, parallel and cylindrical with surfaces smoothly finished.

23.21.3 The area of waterway through the body shall not be less than the area of the circle of diameter equal to the bore of the seating of the tap. The seating of pillar tap shall be integral with the body and edges rounded to avoid cutting of washer. Pillar taps shall be nickel chromium plated and thickness of coating shall not be less than service grade No. 2 of IS 4827 and plating shall be capable of taking high polish which shall not easily tarnish or scale.

23.21.4 Every pillar tap, complete with its component parts shall withstand an internally applied hydraulic pressure of 20 Kg/sq.cm maintained for a period of 2 minutes during which period it shall neither leak nor sweat.

23.22 Sand Cast Iron or Centrifugally Cast (Spun) Iron Pipes and Fittings

23.22.1 Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 1729. Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 3989.
The fittings shall conform to the same I.S. specifications to which the pipe itself conforms in which they are connected.

The pipes shall have spigot and socket ends, with head on spigot end in case of sand cast iron pipes and without head on spigot end in case iron (Spun) pipes. The pipes and fittings shall be true to shapes, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall ring clearly when struck with a light hammer.

The ends of pipes and fittings shall be reasonably square to their axis. The sand cast iron pipes shall be 1.5/1.8/2.0 metre in length including socket ends, cast iron (Spun) pipes shall be 1.5/1.75/2.0/2.5/3.0 metre in length excluding socket ends, unless shorter lengths are either specified or required at junctions etc. The pipe and fittings shall be supplied without ears, unless specified or directed otherwise.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base. The coating material shall have good adherence and shall not scale off.

In all instances where the coating material has tar or similar base it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree centigrade but not so brittle at a temperature of 0 degree centigrade as to chip off when scribed lightly with a pen knife.

The standard weights and thicknesses of pipes and their tolerances shall be as mentioned below.

**STANDARD WEIGHTS AND THICKNESS OF C.I. PIPES**

For Sand Cast Iron Pipes IS 1729

Table No.- 23.3

<table>
<thead>
<tr>
<th>Nominal dia of bore (mm)</th>
<th>Thickness (mm)</th>
<th>Over all weight of pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.5 m long (Kg)</td>
</tr>
<tr>
<td>50</td>
<td>5.0</td>
<td>9.56</td>
</tr>
<tr>
<td>75</td>
<td>5.0</td>
<td>13.83</td>
</tr>
<tr>
<td>100</td>
<td>5.0</td>
<td>18.14</td>
</tr>
<tr>
<td>150</td>
<td>5.0</td>
<td>26.70</td>
</tr>
</tbody>
</table>

For Cast Iron (Spun) Pipes IS 3989.
Table No.- 23.4

<table>
<thead>
<tr>
<th>Nominal dia (mm)</th>
<th>Thickness (mm)</th>
<th>Overall Weight in Kg. for an effective length in metres of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3.000</td>
</tr>
<tr>
<td>50</td>
<td>3.5</td>
<td>13.40</td>
</tr>
<tr>
<td>75</td>
<td>3.5</td>
<td>20.0</td>
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<td>4.0</td>
<td>30.0</td>
</tr>
<tr>
<td>150</td>
<td>5.0</td>
<td>56.0</td>
</tr>
</tbody>
</table>

23.22.7.3 Tolerances on the external diameter of the barrel, the internal diameter of the socket and the depth of socket shall be as follows:

Table No.- 23.5

<table>
<thead>
<tr>
<th>Dimensions (mm)</th>
<th>Nominal Diameter (mm)</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>External diameter of barrel</td>
<td>50, 75</td>
<td>± 3.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>± 3.5</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>± 4.0</td>
</tr>
<tr>
<td>Internal diameter of socket</td>
<td>All diameters</td>
<td>± 3.0</td>
</tr>
<tr>
<td>Depth of socket</td>
<td>All diameters</td>
<td>10.0</td>
</tr>
</tbody>
</table>

23.22.7.4 The maximum and minimum jointing space resulting from these tolerances shall be such that the jointing of the pipes and fittings is not adversely affected.

23.22.7.5 The tolerance on length of pipes shall be ± 20 mm.

23.22.7.6 The tolerances on dimensions of fittings shall be as given below:

Table No.- 23.6

<table>
<thead>
<tr>
<th>Type of Casting</th>
<th>Dimension</th>
<th>Tolerance mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bend pipes</td>
<td>a</td>
<td>+ 25 -10</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>+ 20 -10</td>
</tr>
<tr>
<td>Branches with equal branch pipes</td>
<td>a</td>
<td>+ 25 -10</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>+ 25 -10</td>
</tr>
<tr>
<td>Branches with unequal branch pipes</td>
<td>L</td>
<td>+ 30 -20</td>
</tr>
<tr>
<td>S. Shape casting</td>
<td>L</td>
<td>+ 50 -10</td>
</tr>
<tr>
<td>Taper collars</td>
<td>L</td>
<td>+ 25 -10</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>+ 20 -10</td>
</tr>
</tbody>
</table>

(1) Tolerance on wall-thickness shall be limited to -15 per cent. No limits for plus tolerance is specified.

(2) Tolerance for dimensions other than those specified above shall be as specified in IS 5519.

(3) Tolerance on mass shall be limited to -10 per cent. No limit for plus tolerance Specified.
23.22.8 The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights & thicknesses shall be the same as for straight pipes.

23.22.8.1 The access door fittings shall be designed so as to avoid dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

23.23 **Sand Cast Iron Floor Trap or Nahani Trap**

23.23.1 Sand cast Iron Floor trap or Nahani trap shall be ‘P’ or ‘S’ type with minimum 50 mm seal. However, if the plumbing is in two pipes system and with a gully trap at the ground level the minimum water seal shall be 35 mm. The traps shall be of self cleansing design and shall have exit of same size as that of waste pipe. These shall conform to IS 1729.

23.23.2 Plastic Seat and Covers for Water Closet.

23.23.2.1 The seat and cover shall be of thermosetting or thermoplastic conforming to IS 2548 as specified. Unless otherwise specified these shall be of closed pattern.

23.23.2.2 Thermosetting plastic used shall conform to grade 2 or 3 of IS 1300 when it is phenolic plastic or IS 3389 when of urea formaldehyde.

23.23.2.3 Thermo plastic materials used may be of Polystyrene conforming to type 2 or 3 of IS 2267 or of polypropylene, Appendix A of IS 2548. In public buildings where rough and heavy use of seats and covers are common, plastic seats shall be moulded out of thermosetting materials, phenolic or urea formaldehyde only and the under side of the seat shall be flat with solid moulding.

23.23.2.4 The hinging device shall be bronze or brass with nickel chromium plating confirming to IS 1068 and the seat shall have not less than three rubber or plastic buffers of size 25 mm x 40 mm x 10 mm for closed front seats and not less than four for open front seats, which shall be securely fixed to the under side of the seat unless otherwise specified. The cover shall be fitted with the same number of buffers as provided for the seat.

23.23.2.5 Seats shall have a smooth finish and shall be non absorptive and free from cracks and crevices. They shall be capable of being easily cleaned and shall not be adversely affected by common solvents or household cleanser.

23.24 Strength :

23.24.1 The seats shall withstand without permanent distortion of the seat or hinge fittings or damage to any finish, a load of 1150 N for 30 minutes applied in the manner prescribed in IS 2548.

23.25 Sinks

23.25.1 Laboratory sinks and kitchen sinks shall be of white glazed fire clay conforming to IS 771 (Part-2) with upto date amendments. The kitchen sink shall be of one piece construction with or without rim but without overflow.
23.25.2. Stainless steel kitchen sink shall be of sizes as specified and shall be conforming to IS 13983.

23.26. Towel Rail
23.26.1 The towel rail shall be of PTMT as specified and as per direction of Engineer-in-charge.

23.27. Toilet Paper Holder
23.27.1 The toilet paper holder shall be of CP brass or vitreous china as specified and of size and design as approved by the Engineer-in-Charge. It shall be fixed in position by means of C.P. brass screws and raw plugs embedded in the wall.

23.28. Urinals
23.28.1 Bowl Type Urinals:
23.28.2 Urinal basins shall be of flat back or corner wall type lipped in front. These shall be of white vitreous china conforming to IS 2556 (Part 6). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia 6.5 mm on each side.

23.28.2.1 Each urinal shall have an integral flushing rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the urinals.

23.28.2.2 At the bottom of the urinal an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front towards the outlet such that there is efficient draining.

23.29. Half Stall Urinals:
23.29.1 They shall be of white vitreous China conforming to IS 2556 (Part 6). They shall be of one piece construction with or without an integral flushing box rim and provided with slots or alternative fixing arrangement at the flat back end.

23.29.2 They shall be provided with ridges where integral flushing rim is not provided in the sides of the interior of the bowl, to divert the water toward the front line of the urinal where integral flushing box rim is specified, water spreaders provided shall conform to IS 2556 Part-6. These shall be vitreous China of one piece construction with integral flush inlet. The tolerance of ± 4 per cent may be allowed on the dimensions specified.

23.30. Urinal Partition Slabs:
23.30.1 Urinal Partition slabs shall be provided, as specified in the item of work.

23.31. Squatting Plate Urinal:
23.31.1 The plates shall be of white vitreous china conforming to IS 2556 (Part-1) and IS 2556 (Part-6) with internal flushing rim with front or side inlet. Squatting Plate shall be of one piece construction. Each urinal shall have integral longitudinal flushing pipe of suitable type which may be connected to flush pipe. These shall be 100 mm dia white glazed vitreous china channel with stop and outlet piece in front.

23.32 Wash Basins

23.32.1 Wash basins shall be of white vitreous china conforming to IS 2556 (Part-1) and IS 2556 (Part-4). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim or all sides, except sides in contact with the walls and shall have a skirting at the back. Basins shall be provided with single or double tap holes as specified.

23.32.2 The tap holes shall be 28 mm square or 30 mm round or 25 mm round for pop up hole. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or beveled internally with diameter of 65 mm at top. Each basin shall be provided with a non-ferrous 32 mm waste fitting.

23.32.3 Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses, which shall fully drain into the bowl. A slot type of overflow having an area of not less than 5 sq.cm shall be provided and shall be so designed as to facilitate cleaning of the overflow.

23.32.4 Where oval shape or round shape wash basins are required to be fixed these shall be fixed preferably in RCC platform with local available stone topping either fully sunk in stone top or top flush with the stone topping as directed by Engineer-in-Charge.

23.32.5 The wash basins shall be one of the following patterns and sizes as specified

(a) Flat back: 
   - 660 x 460 mm (Surgeon's Basin)
   - 630 x 450 mm
   - 550 x 400 mm
   - 450 x 300 mm

(b) Angle back: 
   - 600 x 480 mm
   - 400 x 400 mm

23.32.6 White glazed pedestals for wash basins, where specified shall be provided. The quality of the glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so
designed as to make the height from the floor to top of the rim of basin 75 to 80 cm. All the waste fittings shall be brass chromium plated, or as specified.

23.33 Waste Fittings for Wash Basins and Sinks

23.33.1 The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respects to IS 2963 and shall be sound, free from laps, blow holes and fittings and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

23.33.2 Waste fitting for wash basins shall be of nominal size of 32mm. Waste fittings for sinks shall be of nominal size 50mm.

23.34 Water Closet

23.35 Squatting Pans (Indian Type W.C.) :

23.35.1 Squatting pans shall be of white vitreous china conforming to IS 2556 Part-1 for General Requirements and relevant IS codes for each pattern as described below:

23.36 Long pattern-conforming to IS 2556 (Part-3)

(ii) Orissa pattern-conforming to IS 2556 (Part-3)

(iii) Integrated type conforming to IS 2556 (Part-14).

Preferably Orissa type pan should be used.

23.36.1 Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer-in-Charge.

23.36.2 The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surfaces shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a (100 mm) S.C.I. trap ‘P’ or ‘S’ type with approximately 50 mm water seal and 50 mm dia vent horn, where required by the Engineer-in-Charge.

23.37 Wash Down Type (European Type W.C.) :

23.37.1 Water closets shall be of white vitreous chain conforming to IS 2556 (Part-1) and 2556 (Part-2), as specified and shall be of ‘Wash down type’. The closets shall be either of the two patterns (Pattern I & Pattern II) and sizes as specified. The closets shall be of one piece construction. Each water closet shall have not less than two holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type.
23.37.2 It shall also have an inlet or supply horn for connecting the flushing pipe of dimensions. The flushing rim may be boxed or open type. In the case of box rims adequate number of holes, on each side together with a slot opposite the inlet shall be provided. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either ‘S’ or ‘P’ outlet with a least 50mm water seal. For P trap, the slope of the outlet shall be 14 deg. Below the horizontal.

23.37.3 Where required the water closet shall have an antisiphonage 50mm dia vent horn on the outlet side of the trap with dimension conforming to those on either right or left hand or centre as specified set at an angle of 45 deg and invert of vent hole not below the central line of the outlet. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush.

23.37.4 The serrated part of the outlet shall not be glazed externally. The water closet, when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 litres of water between the normal water level and the highest possible water level of the water closet as installed.

23.38 GENERAL REQUIREMENTS FOR INSTALLATION OF W.C. PAN

23.38.1 The work shall be carried cut, complying in all respect with the requirements of relevant bye-laws of the local body in whose jurisdiction the work in situated.

23.38.2 Any damage caused to the building, or to electrical, sanitary, water supply or other, installations etc. therein, either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the contractor. Nothing extra shall be paid for such restoration works except where otherwise specified.

23.38.2.1 Masonry Work : The masonry work shall be made good by using the same class of bricks, tiles or stones as was damaged during the execution of the work. The mortar used shall be cement mortar 1:5 (1 cement : 5 fine sand) or as directed by the Engineer-in-Charge.

23.38.2.2 Plain Concrete Work : Concrete work for sub-grade of the flooring, foundations and other plain concrete work shall be cement concrete 1:5:10 (1cement : 5 coarse and: 10 graded stone aggregate 40mm nominal size). A coat of neat cement slurry shall be applied at the junction with old work, before laying fresh concrete.

23.38.2.3 Cement Concrete Flooring and R.C.C. Work : Cement concrete 1:2:4 (1 Cement : 2 Coarse sand : 4 graded stone aggregate 20mm nominal size) shall be used after applying a coat of neat cement slurry at the junction with old work, and the surface finished to match with the surrounding surface.

23.38.2.4 Plastering : Cement plaster 1:4 (1 cement : 4 sand) shall be used. The sand shall be fine or coarse, as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or
painting as required, but where the surface is not to be white washed, colour washed, distempered or painted, it shall be finished as required to match with the surrounding surface.

23.38.2.5 Other Items: Damage to any other item shall be made good as directed by the Engineer-in-Charge.

23.38.3 In all the above operations the damaged portion shall be cut in regular geometric shape and cleaned before making good the same.

23.38.3.1 All exposed G.I., C.I. or lead pipes and fittings shall be painted with approved quality of paint and shade as specified. The painting work shall conform to specification described under Chapter of painting in Building SOR.

23.38.3.2 All sanitary and plumbing work shall be carried out through licensed plumbers.

23.38.3.3 On completion of the work the site shall be cleaned and all rubbish disposed of as directed by the Engineer-in-Charge.

23.38.3.4 Various sanitary fittings described under 25.2 including fixing shall be enumerated individually or in combination under relevant items of works as described below. When used in combination, specifications as described under relevant paras shall apply but nothing extra shall be paid for making connections required for successful functioning of the combination.

23.39 INSTALLATION OF DRAINING BOARD

23.39.1 Fixing

23.39.1.1 One end of the board shall rest on sink and the other end shall be supported on C.I. bracket, embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. The brackets used shall be of cantilever type or wall fixed type as for the sink.

23.39.2 Painting

23.39.2.1 The brackets shall be painted with two or more coats of approved paint.

23.39.3 Measurements

23.39.3.1 Draining board shall be measured in numbers.

23.39.4 Rate

23.39.4.1 The rate shall include the cost of all materials and labour involved in all operations.

23.40 INSTALLATION OF FLUSHING CISTERN

23.40.1 Fixing

23.40.1.1 Low Level Cistern:

23.40.1.1.1 The cistern shall be fixed on C.I. cantilever brackets which shall be firmly embedded in the wall in cement concrete (1:2:4) block 100 x 75 x 150 mm. Connection between cistern and closet shall be made by means of 40 mm dia flush bend with rubber of G.I. inlet connection as specified.
23.40.2 Automatic Cistern:
23.40.2.1 Clause 17.41.1.1 shall apply except that CP Brass stop cock shall be provided for cistern having a capacity of more than 5 litre. The main & distribution flush pipe shall be fixed to the wall by means of standard pattern holder bat clamp.

23.40.3 Painting
23.40.3.1 The brackets shall be painted, if specified, with two or more coats of paint of approved shade and quality.

23.40.4 Measurements
23.40.4.1 Cistern, including all fittings, shall be measured in numbers.

23.40.5 Rate
23.40.5.1 The rate shall include the cost of all materials and labour involved in all the operations described above.

23.41 Installation of mirror
23.41.1 Fixing
23.41.1.1 The mirror shall be mounted on backing with environmentally friendly material other than asbestos cement sheet shall be fixed in position by means of 4 C.P. brass screws and C.P. brass washers, over rubber washers and wooden plugs firmly embedded in walls C.P. brass clamps with C.P. brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

23.41.2 Measurements
23.41.2.1 Mirror shall be measured in numbers.

23.41.3 Rate
23.41.3.1 Rate shall include the cost of all the materials and labour involved in all the operations described above.

23.42 FIXING AND JOINTING OF PIPES AND FITTINGS
23.42.1 The specifications described in sub-head 12.0 shall apply, as far as applicable, except that the joint shall be lead caulked. All soil pipes shall be carried up above the roof and shall have sand cast iron terminal guard.

23.42.2 Height of Ventilating Pipes
23.42.2.1 The ventilating pipe or shaft shall be carried to a height of at least 60 cms above the outer covering of the roof of the building or in the cases of a window in a gable wall or a dormer window it shall be carried up to the ridge of the roof or at least 2 metres above the top of the window.

23.42.2.2 In the case of a flat roof to which access for use is provided it shall be carried up to a height of 2 metres above the roof and shall not terminate within 2 metre, measured vertically from the top of any window opening which may exist
up to a horizontal distance of 3 meters from the vent pipe into such building and in no case shall be carried to a height less than 3 metres above plinth level. In case the adjoining building is taller, the ventilating pipe shall be carried higher than the roof of the adjoining building, wherever it is possible.

23.42.2.3 The pipes above the parapet shall be secured to the wall by means of M.S. stay and clamps as specified in 25.21.

23.42.2.4 The connections between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning. The waste from lavatories, kitchen, basins, sinks, baths and other floor traps shall be separately connected to respective waste stack of upper floors.

23.42.2.5 The waste stack of lavatories shall be connected directly to manhole while the waste stack of others shall separately discharge over gully trap. Where single stack system is provided, the connection shall be made direct to the manhole.

23.42.3 Jointing

23.42.3.1 The interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of treated spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment.

23.42.3.2 The leading of pipes shall be made by means of ropes covered with clay or by using special leading rings. The lead shall be melted so as to thoroughly fluid and each joint shall be filled in one pouring.

23.42.4 The following precautions shall be taken for melting lead:

(a) The pot and the ladle in which lead shall be put shall be clean and dry.

(b) Sufficient quantity of lead shall be melted.

(c) Any scum or dross which may appear on the surface of the lead during melting shall be skimmed off.

(d) Lead shall not be overheated.

23.42.4.1 After the lead has been run into the joint the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipes has been laid and leaded.

23.42.4.2 The leading ring shall first be removed and any lead outside the socket shall be removed with a flat chisel and then the joint caulked round three times with caulking tools of increasing thickness and hammer 2 to 3 Kg. weight. The joints shall not be covered till the pipe line has been tested under pressure.

23.42.4.3 Use of collars for jointing is not permitted in any concealed or embedded locations. However, in exposed locations where full length pipes cannot be fixed due to site constraints, collars (and not loose sockets) may be used subject to the following:
(a) No two consecutive joint shall be with the use of collars.

(b) The joint of collar with the cut/spigot end of the pipe shall be made on the ground in advance and tested against leakage before fixing.

(c) Cut/spigot end of the pipes shall be inserted in the collars up to the projection inside the collar and jointing shall be done as in the case of socket and spigot joint. The jointed pipe line shall be at required level/slope and alignment.

Table No.- 23.7

<table>
<thead>
<tr>
<th>As marked in fig</th>
<th>Pipe dia (size in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>a</td>
<td>78</td>
</tr>
<tr>
<td>b</td>
<td>50</td>
</tr>
<tr>
<td>c</td>
<td>10</td>
</tr>
<tr>
<td>d</td>
<td>79</td>
</tr>
<tr>
<td>e</td>
<td>69</td>
</tr>
</tbody>
</table>

Note: The dimensions of loose sockets shall correspond to those of appropriate nominal size of pipe.

23.42.5 Testing

23.42.5.1 In order to ensure that adequate lead is poured properly into the joints and to control waste in use of lead, at the beginning of work three or four sample joints shall be made and the quantum of lead per joint approved by the Engineer-in-Charge. All sand cast iron/cast iron (Spun) pipes and fittings including joint shall be tested by smoke test to the satisfaction of the Engineer-in-Charge and left in working order after completion.

23.42.5.2 The smoke test shall be carried out as under. Smoke shall be pumped into the pipes at the lowest end from a smoke machine which consists of a bellow and burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell, if there is leak at any point of the drain.

23.42.6 Painting

23.42.6.1 All sand cast iron/cast iron (Spun) pipes and fittings shall be painted with shade to match the colour of the background as directed by the Engineer-in-Charge.

23.42.7 Measurements
23.42.7.1 The pipes shall be measured net when fixed in position excluding all fittings along its length, correct to a cm.

23.42.7.2 When collars are used for jointing SCI pipes these shall be measured as fittings and shall be paid for separately.

23.42.7.3 No allowance shall be made for the portions of the pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to both cases i.e. whether the pipes are fixed on wall face or embedded in masonry.

23.42.7.4 No deduction shall be made in the former case from the masonry measurement for the volume of concrete blocks embedded therein. Similarly no deduction shall be made for the volume occupied by the pipes from the masonry when the former are embedded in the later.

23.42.8 Rates

23.42.8.1 The rate shall include the cost of all labour and materials involved in all the operations described above, excluding fittings, lead caulk jointing, the supply and fixing M.S. holder bat clamps and M.S. stays and clamps, floor trap and painting, which shall be paid for separately.

23.43 INSTALLATION OF SEAT AND COVER TO WATER CLOSET

23.43.1 Fixing

23.43.1.1 The seat shall be fixed to the pan by means of two corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 25 mm of the flange supplied by the manufacturer along with the seat. Each bolt shall be provided with two suitably shaped washers or rubber or other similar materials for adjusting the level of the seat while fixing it to the pans.

23.43.1.2 In addition, one non-ferrous or stainless steel washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25 mm. Alternative hinging devices as supplied by the manufacturer of the seat can also be used for fixing with the approval of Engineer-in-Charge.

23.43.2 Measurements

23.43.2.1 Seat with cover shall be measured in numbers.

23.43.3 Rate

23.43.3.1 Rate shall include the cost of all the materials and labour involved in all the operations described above.

23.44 INSTALLATION OF SINK

23.44.1 The installation shall consist of assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

23.44.2 Fixing
23.44.2.1 The sink shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75x 150 mm. Brackets shall be fixed in position before the dado work is done. The C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or PVC waste pipe which shall be suitably bend towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

23.44.3 Measurements

23.44.3.1 The sinks shall be measured in numbers.

23.44.4 Rate

23.44.4.1 Rate shall include the cost of all materials and labour involved in all the operations described above but shall not included the cost of waste fitting and brackets which shall be paid for separately.

23.45 INSTALLATION OF URINAL LIPPED, HALF STALL (SINGLE OR RANGE)

23.45.1 Urinal installation shall consist of a lipped urinal (Single or range), an automatic flushing cistern, G.I. flush and waste pipe. The capacity of flushing cistern and relevant size of flush pipe for urinals in a range shall be as prescribed in Table 25.9

23.45.2 Waste pipe shall be of 32 mm nominal bore G.I. pipe and shall be paid separately.

23.45.3 Fixing

23.45.3.1 Urinals shall be fixed in position by using wooden plugs and screws. It shall be at a height of 65 cm from the standing level to the top of the lip of the urinal, unless otherwise directed by the Engineer-in-Charge. The size of wooden plugs shall be 50 mm x 50 mm at base tapering to 38 mm x 38 mm at top and of length 5.0 cms. These shall be fixed in the wall in cement mortar 1:3 (1 cement: 3 fine sand). After the plug fixed in the wall, the mortar shall be cured till it is set.

<table>
<thead>
<tr>
<th>No. of Urinals in range</th>
<th>Capacity of Flushing Cistern</th>
<th>Size of Flush Pipe (Galvanised Iron)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Main</td>
</tr>
<tr>
<td>One</td>
<td>5 Litres</td>
<td>15 mm</td>
</tr>
<tr>
<td>Two</td>
<td>10 Litres</td>
<td>20 mm</td>
</tr>
<tr>
<td>Three</td>
<td>10 Litres</td>
<td>25 mm</td>
</tr>
<tr>
<td>Four</td>
<td>15 Litres</td>
<td>25 mm</td>
</tr>
</tbody>
</table>
23.45.3.2 Each urinal shall be connected to 32mm dia waste pipe which shall discharge into the channel or a floor trap. The connection between the urinal and flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

23.45.4 Measurements

23.45.4.1 Urinal shall be measured in numbers.

23.45.5 Rate

23.45.5.1 Rate shall include the cost of all the materials and labour involved in all the operations described above.

23.46 INSTALLATION OF STALL URINAL (SINGLE OR RANGE)

23.46.1 The installation shall consist of stall urinal (single or range), automatic flushing cistern, C.P. brass standard flush pipes, C.P. brass spreader and C.I. trap with tail piece and outlet grating of C.P. brass. Capacity of flushing cistern and relevant size of flush pipe, C.I. trap shall be as prescribed in Table 23.9

TABLE 23.9

<table>
<thead>
<tr>
<th>No. of Urinals in range</th>
<th>Capacity of Flushing cistern</th>
<th>Size of Flush Pipe (Chromium Plated)</th>
<th>Diameter of C.I. Traps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Main</td>
<td>Distribution</td>
</tr>
<tr>
<td>One</td>
<td>05 Litres</td>
<td>15 mm</td>
<td>15 mm</td>
</tr>
<tr>
<td>Two</td>
<td>10 Litres</td>
<td>20 mm</td>
<td>15 mm</td>
</tr>
<tr>
<td>Three</td>
<td>15 Litres</td>
<td>25 mm</td>
<td>15 mm</td>
</tr>
<tr>
<td>Four</td>
<td>15 Litres</td>
<td>25 mm</td>
<td>15 mm</td>
</tr>
</tbody>
</table>

23.46.2 Fixing

23.46.2.1 The floor slab shall be suitably sunk to receive the stall urinal. Where the floor slab is not sunk, the stall urinal shall be provided over a platform. The lip of the stall urinal shall be flush with the finished floor level adjacent to it. The stall urinal shall be laid over a fine sand cushion of average 25 mm thickness.

23.46.2.2 A space of not less than 3 mm shall be provided all-round, in front, side and filled with waterproofing plastic compound. Care shall be taken that after the sub-grade for the floor is cast, one week should lapse before urinals are installed. The trap and fittings shall be fixed as directed by the Engineer-in-Charge. Payment for the floor and its sub-grade shall be made separately.

23.46.3 Measurements

23.46.3.1 Stall urinals shall be measured in numbers.
23.46.4 Rate

23.46.4.1 The rate shall include the cost of all the materials and labour involved in all the operations described above.

**23.47 Installation of wash basin**

23.47.1 The installation shall consist of an assembly of wash basin, pillar taps, C.I. brackets, C.P. brass of P.V.C. union, as specified. The wash basin shall be provided with one or two 15mm C.P. brass pillar taps, as specified. The height of top of the rim of wash basin from the floor level shall be within 750mm to 800 mm.

23.47.2 Fixing

23.47.2.1 The basin shall be supported on a pair C.I. cantilever brackets conforming to IS 775 and be embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. Use of M.S. angle or Tee section as bracket is not permitted. Brackets shall be fixed in position before dado work is done. The wall plaster on the rear shall be cut to rest over the top edge of the basin so as not to leave any gap for water to seep through between wall plaster & skirting of basin.

23.47.2.2 After fixing the basin, plaster shall be made good and surface finished matching with the existing one. S.C.I. floor traps conforming to IS 1729 having 50 mm water seal (minimum 35 mm in two pipe systems with gully trap) should be used. Waste pipes laid horizontally should have gradient not flatter than 1 in 50 and not steeper than 1 in 10.

23.47.2.3 The waste water from wash basin shall be discharged directly to vitreous semi-circular open drain, discharging to a floor trap and finally to the vertical stack on upper floors and in case of ground floor, the waste water shall be discharged either directly to the gully trap or through the floor trap C.P. brass trap and union are not to be used in such situations.

23.47.2.4 If waste pipe is concealed or crosses the wall, waste water shall be discharged through non ferrous trap like PVC Engineering plastic or C.P. brass and union to vertical stack. The C.P. brass trap and union shall be paid for separately.

23.47.2.5 Where so specified a 20 mm G.I. puff pipe terminating with a perforated brass cap screwed on it on the outside of the wall or connected to the antisyphon stack shall be provided.

23.47.3 Measurements

23.47.3.1 Wash basins shall be measured in numbers.

23.47.4 Rate

23.47.4.1 The rate shall include the cost of all the materials and labour involved in all the operations described above.

**23.48 Installation of squatting pan**
The installation shall consist of squatting pan, flushing cistern, flush pipe and a pair of foot rests.

Fixing

The pan shall be sunk into the floor and embedded in a cushion of average 15 cm brick cement concrete 1:5:10 (1 Cement : 5 fine sand : 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so as to allow flooring and its bed concrete.

The pan shall be provided with a 100 mm S.C.I., P or S type trap with an approximately 50 mm seal and 50 mm dia vent horn, where required by the Engineer-in-Charge. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1 Cement : 1 fine sand).

Measurements

The squatting pans shall be measured in numbers.

Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above. Cost of concrete shall be paid separately.

Installation of water closet

Installation shall consist of water closet with seat and cover, flushing cistern and flush bend.

Fixing

The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter-sunk bolts and nuts embedded in floor concrete.

Measurements

Water closets shall be measured in numbers.

Rate

Rates shall include the cost of all the materials and labour involved in all the operations described above.

Installation of foot rests

After laying the floor around squatting pan as specified a pair of foot rests shall be fixed in cement mortar 1:3 (1 cement : 3 coarse sand). The position of foot rests with respect to pan.

Measurements

Pair of foot rests shall be measured in numbers.

Rate
23.50.3.1 Rate shall include the cost of all the materials and labour involved in all the operations described above.

23.51 INSTALLATION OF SQUATTING PLATE (SINGLE OF RANGE)

23.51.1 The installation shall consist of an assembly of squatting plates (single or range), vitreous China channel, automatic flushing cistern, flush pipe with fittings spreader and C.I. trap. The capacity of flushing cistern and relevant size of flush pipes shall be as specified in Table 23.10.

<table>
<thead>
<tr>
<th>No. of Squatting Plates in range</th>
<th>Capacity of Flushing Cistern</th>
<th>Size of Flush Pipe (Galvanised Iron)</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>5 Litres</td>
<td>Main: -</td>
</tr>
<tr>
<td>Two</td>
<td>10 Litres</td>
<td>25 mm</td>
</tr>
<tr>
<td>Three</td>
<td>15 Litres</td>
<td>32 mm</td>
</tr>
<tr>
<td>Four</td>
<td>15 Litres</td>
<td>32 mm</td>
</tr>
</tbody>
</table>

23.51.2 Fixing

23.51.2.1 The floor slab shall be suitably sunk to receive the squatting plate. Where the floor slab is not sunk, the plates shall be provided over a platform. The top edge of the squatting plate shall be flush with the finished floor level adjacent to it. It shall be embedded on a layer of 25 mm thick cement mortar 1:8 (1 cement : 8 fine sand) laid over a bed of cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded brick aggregate 20 mm nominal size).

23.51.2.2 There shall be 100 mm dia, white glazed vitreous China channels with stop and outlet pieces suitably fixed in the floor in cement mortar 1:3 (1 cement : 3 coarse sand) and joint finished with white cement. The squatting plate shall have 1200 high and half brick thick wall in front and on either side of the squatting plate. The brick work for the walls shall be paid separately.

23.51.2.3 The exposed surface of walls shall be lined with white glazed tiles with proper corners and angles set in neat cement mortar, the face of the joints shall be gone over with whiting so as to match with the colour of the tiles. The tiles shall be 15mm square. Space if any, left between the side walls and squatting plate shall be finished white to match the colour of the squatting plate. The trap and fittings shall be fixed as directed by the Engineer-in-Charge. The vitreous China channel shall discharge into 65 mm diameter standard urinals, C.I. trap with vent arm having 65 mm C.P. brass outlet grating.

23.51.3 Measurements

23.51.3.1 Squatting plates shall be measured in numbers.

23.51.4 Rate

23.51.4.1 The rate shall include the cost of all the materials and labour involved in all the operations described above.
23.52 INSTALLATION OF TOWEL RAIL

23.52.1 It shall be fixed in position by means of C.P. brass screws on wall surface by PVC dash fasteners, firmly embedded in wall.

23.52.2 Measurements

23.52.2.1 Towel rails shall be measured in numbers.

23.52.3 Rate

23.52.3.1 Rate shall include the cost of all the materials and labour involved in all the operations described above.
FLUSHING CISTERNs

AUTOMATIC TYPE

Body is Shown in Half Section

CURVED SIPHON TYPE

BELL TYPE

Drawing Not to Scale
All Dimensions are in mm

Fig: No:1
Fig. 2: Foot Rest
Fig. 3 : M.S Stays and Clamp
PLASTIC SEAT AND COVER

Table

1. Dimensions of seats and cover all dimensions in millimeter's

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Distance form center line of hinge bolts to extreme edge of rim at fornt, A</td>
<td>445</td>
<td>475</td>
</tr>
<tr>
<td>2.</td>
<td>Length of opening at longest point, B</td>
<td>250</td>
<td>290</td>
</tr>
<tr>
<td>3.</td>
<td>Width of opening at widest point, C</td>
<td>215</td>
<td>240</td>
</tr>
<tr>
<td>4.</td>
<td>Overall width at widest point, D</td>
<td>380</td>
<td>-</td>
</tr>
<tr>
<td>5.</td>
<td>Distance between inner and outer rims, E</td>
<td>55</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Centre-to-centre distance of seat bolt holes, F</td>
<td>145</td>
<td>175</td>
</tr>
<tr>
<td>7.</td>
<td>Distance from centre line of hinge bolts to inner rim of seat at the back, G</td>
<td>85</td>
<td>-</td>
</tr>
<tr>
<td>8.</td>
<td>Thickness of seat at thinnest point</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>9.</td>
<td>Thickness of cover at thinnest point</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>

Note:- Some hinging devices are made so as to provide adjustment in the longitudinal direction. This is not precluded by these figures.

Fig. 4: Plastic Seat and cover
DIMENSIONS OF KITCHEN AND LABORATORY SINKS
(White Glazed Fire Clay)
All dimensions in millimeters

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Kitchen sinks</td>
<td>750</td>
<td>450</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>600x450x250</td>
<td>600</td>
<td>450</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>600x450x200</td>
<td>600</td>
<td>450</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>(b)</td>
<td>Laboratory sinks</td>
<td>600</td>
<td>400</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>500x350x150</td>
<td>600</td>
<td>350</td>
<td>150</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>450x300x150</td>
<td>450</td>
<td>300</td>
<td>150</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>400x250x150</td>
<td>400</td>
<td>250</td>
<td>150</td>
<td>90</td>
</tr>
</tbody>
</table>

Reference to Fig. above

<table>
<thead>
<tr>
<th>Reference to Fig. above</th>
<th>Dimensions in mm (Minimum Unless Specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>380 (for rectangular bowl)</td>
</tr>
<tr>
<td></td>
<td>360 (for round bowl)</td>
</tr>
<tr>
<td>b</td>
<td>340</td>
</tr>
<tr>
<td>c</td>
<td>20</td>
</tr>
<tr>
<td>d</td>
<td>30</td>
</tr>
<tr>
<td>e</td>
<td>45</td>
</tr>
<tr>
<td>f</td>
<td>440 mm Max for 500 mm worktop</td>
</tr>
<tr>
<td></td>
<td>515 mm Max for 600 mm worktop</td>
</tr>
</tbody>
</table>

Fig. 5: Kitchen & Laboratory Sinks
Fig. 6: Waste Fittings for W.B. & Sinks
Note: Ovality of 5 percent is permissible on inlet and outlet diameters.
All dimensions in millimeters.

Fig. 7: Urinal Bowl Type (Corner Wall Type)
URINAL SQUATTING PLATE

FUNCTIONAL DIMENSIONS OF SQUATTING PLATES (IN MM)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Ref. in Fig. Above</th>
<th>Size 1</th>
<th>Size 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Size</td>
<td></td>
<td>450x350</td>
<td>600x350</td>
</tr>
<tr>
<td>2.</td>
<td>Length</td>
<td></td>
<td>450</td>
<td>600</td>
</tr>
<tr>
<td>3.</td>
<td>Minimum footrest width</td>
<td>w1</td>
<td>125</td>
<td>165</td>
</tr>
<tr>
<td>4.</td>
<td>Width</td>
<td>W</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>5.</td>
<td>Height at backand</td>
<td>H1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>6.</td>
<td>Height at front end</td>
<td>H2</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>7.</td>
<td>Minimum height at bowl draining surface</td>
<td>H3</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>8.</td>
<td>Width at flat top</td>
<td>w2</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>9.</td>
<td>Radius of curvature of the bowl</td>
<td>R</td>
<td>85</td>
<td>65</td>
</tr>
<tr>
<td>10.</td>
<td>Angle of direction of the two end spray hole with</td>
<td>()</td>
<td>30°</td>
<td>30°</td>
</tr>
</tbody>
</table>

Joviality is permissibal within the variation allowed for the dimension.

CONNECTION DIMENSIONS OF SQUATTING PLATES, MM

<table>
<thead>
<tr>
<th>Description</th>
<th>Ref. in Fig. above</th>
<th>Size 1/Size 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter of in lethole</td>
<td>d1</td>
<td>40</td>
</tr>
<tr>
<td>Diameter of the inlet socket</td>
<td>d2</td>
<td>50</td>
</tr>
<tr>
<td>Depth of the inlet socket, Min</td>
<td>e</td>
<td>25</td>
</tr>
</tbody>
</table>

Fig. 8 : Urinal Squatting Plate
SPREADER FOR URINAL

Fig. 9: Spreader for Urinal

Drawing Not to Scale
All dimensions are in mm
# Wash Basins

![Wash Basin Diagram](image)

## Functional Dimensions of Wash Basins

All dimensions in millimeters

<table>
<thead>
<tr>
<th>No</th>
<th>Pattern</th>
<th>Size</th>
<th>Length</th>
<th>Breadth</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flat Back</td>
<td>650 x 400</td>
<td>160</td>
<td>250</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>600 x 400</td>
<td>150</td>
<td>250</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>550 x 400</td>
<td>145</td>
<td>250</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No</th>
<th>Pattern</th>
<th>Size</th>
<th>Length</th>
<th>Breadth</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Angle Back</td>
<td>520 x 650</td>
<td>160</td>
<td>250</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>420 x 500</td>
<td>140</td>
<td>240</td>
<td>60</td>
</tr>
</tbody>
</table>

Fig. 10: Wash Basins
FIXING ARRANGEMENT OF WASH BASIN  
(ELEVATION OF WASH BASIN)

Location: General Offices. Waste discharging in horizontal open channel, waste controlled in floor trap.

Notes:
1. Slope: 1 in 10 to 1 in 50.
3. Waste Pipe: PVC, flexible Type (32 mm).
4. F.T. Location preferred to achieve Max. Slope.
5. Water supply connection not shown.

TYPICAL ELEVATION OF 3 WASH BASINS IN A ROW

TYPICAL DETAIL OF BOTTLE TRAP

C.V. BRACKET

Note: Studding shall be provided for supports intended for glazed earthenware wash basins only.

Fig. 11: Fixing Arrangement of Wash Basin
Fig. : 12 : Typical Vertical Section of Wash Basin
ANGI F RACK WASH BASIN
(PATTERN-2)

Notes:
1. Tap hole provisions are not shown. However provision shall be made for 1 or 2 Tap holes in any suitable position.
2. Stud provisions are not shown but suitable provision shall be made for fixing purposes.
3. Provision of soap recess need not be central in the case of single tap hole.
4. Drawing not to scale.
5. All dimensions are in mm.

Fig.13: Angle Back Wash Basin (Pattern-2)
### FUNCTIONAL DIMENSIONS OF LNG AND ORISSA PATTERN

**ALL DIMENSIONS IN MILLIMETRES**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>ref. in fig 19 and 20</th>
<th>long attem of size</th>
<th>orissa pattern of size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>length</td>
<td>A</td>
<td>580</td>
<td>630</td>
</tr>
<tr>
<td>2</td>
<td>length of opening min</td>
<td>B</td>
<td>480</td>
<td>530</td>
</tr>
<tr>
<td>3</td>
<td>height</td>
<td>F</td>
<td>300 ± 10</td>
<td>320 ± 10</td>
</tr>
<tr>
<td>4</td>
<td>width of opening, small and</td>
<td>H</td>
<td>170 ± 10</td>
<td>170 ± 10</td>
</tr>
<tr>
<td>5</td>
<td>width of opening, wide end</td>
<td>I</td>
<td>260 ± 10</td>
<td>260 ± 10</td>
</tr>
<tr>
<td>6</td>
<td>slope of bottom of pan</td>
<td>O</td>
<td>15°</td>
<td>15°</td>
</tr>
<tr>
<td>7</td>
<td>Distance between the center of out let to the inside face of flushing on at the back max</td>
<td>L</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>8</td>
<td>width</td>
<td>N</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Length of foot rest</td>
<td>P</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Fig. 14 : Long Pattern Squatting Pan, Type-1
ORISSA PATTERN SQUATTING PAN

Note: Footrest may be flushed or raised, clearance permissible between raised footrest and rim opening.

All dimensions in Millimeters

Fig.15: Orissa Pattern Squatting Pan
INTEGRATED SQUATTING PAN

Fig. 16: Integrated Squatting Pan
PATTERN 1 AND PATTERN 2 WATER CLOSETS

Fig. 17: Pattern 1 and Pattern 2 Water Closets

All dimensions in millimeters
APPENDIX A

STANDARD WEIGHTS AND THICKNESS OF C.I. PIPES
(Clause 17.1.8)

For Sand Cast Iron Pipes IS 1729

<table>
<thead>
<tr>
<th>Nominal dia of bore (mm)</th>
<th>Thickness (mm)</th>
<th>Over all weight of pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.5 m long (Kg)</td>
</tr>
<tr>
<td>50</td>
<td>5.0</td>
<td>9.56</td>
</tr>
<tr>
<td>75</td>
<td>5.0</td>
<td>13.83</td>
</tr>
<tr>
<td>100</td>
<td>5.0</td>
<td>18.14</td>
</tr>
<tr>
<td>150</td>
<td>5.0</td>
<td>26.70</td>
</tr>
</tbody>
</table>

For Cast Iron (Spun Pipes IS 3989).

<table>
<thead>
<tr>
<th>Nominal dia (mm)</th>
<th>Thickness (mm)</th>
<th>Overall Weight in Kg. for an effective length in metres of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>3.000</td>
</tr>
<tr>
<td>50</td>
<td>3.5</td>
<td>13.40</td>
</tr>
<tr>
<td>75</td>
<td>3.5</td>
<td>20.0</td>
</tr>
<tr>
<td>100</td>
<td>4.0</td>
<td>30.0</td>
</tr>
<tr>
<td>150</td>
<td>5.0</td>
<td>56.0</td>
</tr>
</tbody>
</table>

Tolerances

(a) Tolerances on the external diameter of the barrel, the internal diameter of the socket and the depth of socket shall be as follows:—

<table>
<thead>
<tr>
<th>Dimensions (mm)</th>
<th>Nominal Diameter (mm)</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>External diameter of barrel</td>
<td>50, 75</td>
<td>± 3.0</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>± 3.5</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>± 4.0</td>
</tr>
<tr>
<td>Internal diameter of socket</td>
<td>All diameters</td>
<td>± 3.0</td>
</tr>
<tr>
<td>Depth of socket</td>
<td>All diameters</td>
<td>± 10.0</td>
</tr>
</tbody>
</table>

The maximum and minimum jointing space resulting from these tolerances shall be such that the jointing of the pipes and fittings is not adversely affected.

The tolerance on length of pipes shall be ± 20 mm.

(b) The tolerances on dimensions of fittings shall be as given below:

<table>
<thead>
<tr>
<th>Type of Casting</th>
<th>Dimension</th>
<th>Tolerance mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bend pipes</td>
<td>a</td>
<td>+25 -10</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>+20 -10</td>
</tr>
<tr>
<td>Branches with equal branch pipes</td>
<td>a</td>
<td>+25 -10</td>
</tr>
<tr>
<td></td>
<td>b</td>
<td>+25 -10</td>
</tr>
<tr>
<td>Branches with unequal branch pipes</td>
<td>L</td>
<td>+30 -20</td>
</tr>
<tr>
<td>S. Shape casting</td>
<td>L</td>
<td>+50 -10</td>
</tr>
<tr>
<td>Taper collars</td>
<td>L</td>
<td>+25 -10</td>
</tr>
<tr>
<td>Other</td>
<td>L</td>
<td>+20 -10</td>
</tr>
</tbody>
</table>

Note:

(1) Tolerance on wall-thickness shall be limited to −15 per cent. No limits for plus tolerance is specified.

(2) Tolerance for dimensions other than those specified above shall be as specified in IS 5519.

(3) Tolerance on mass shall be limited to −10 per cent. No limit for plus tolerance specified.
23. **Applicable of Codes**

<table>
<thead>
<tr>
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<th>Title</th>
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<td>Specification for glazed fire clay sanitary appliances: Part 2: Specific requirements of kitchen and laboratory sink.</td>
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<td>Specific action for general requirements for enameled cast iron sanitary appliances.</td>
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<td>Flushing cisterns for water closets and urinals (Other than plastic cistern): Specifications.</td>
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<td>Cast Iron/Ductile Iron Drainage Pipes and pipe fittings for Over ground non-pressure pipe line socket and spigot series.</td>
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<tr>
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<td>IS 2556</td>
<td>Vitreous Sanitary appliances (Vitreous china): Specifications</td>
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<tr>
<td>IS 2556 (Part-1)</td>
<td>Part 1: General requirements</td>
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<tr>
<td>IS 2556 (Part-2)</td>
<td>Part 2: Specific requirements of wash-down water closets.</td>
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<tr>
<td>IS 2556 (Part-3)</td>
<td>Part 3: Specific squatting pans.</td>
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<td>Part 4: Specific requirements of wash basins.</td>
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<td>IS 2556 (Part-5)</td>
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</tr>
<tr>
<td>Standard</td>
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<tr>
<td>IS 2556 (Part-14)</td>
<td>Part 14: Specific requirements of integrated squatting pans.</td>
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<tr>
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<tr>
<td>IS 4827</td>
<td>Specification for electroplated coating of nickel and chromium on copper and copper alloys.</td>
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<tr>
<td>IS 4984</td>
<td>Specifications for high density polyethylene pipes for potable water supplies.</td>
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<td>IS 4985</td>
<td>Un-plasticized P.V.C. pipes for potable water supply – Specifications.</td>
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<tr>
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<td>Plastic flushing cisterns for water closets and urinals – Specifications</td>
</tr>
<tr>
<td>IS 13983</td>
<td>Stainless steel sinks for domestic purposes – Specifications.</td>
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