SECTION - 2
EARTHWORK & FOUNDATIONS
PART I – EARTHWORK

2.1 Classification of soils - The earthwork shall be classified under the following categories and measured separately for each category, unless otherwise specified.

The material to be excavated shall be classified as follows: -

a) Ordinary or soft soil - Generally any soil which yields to ordinary application of pick axes, shovels or any other ordinary digging implements, such as organic soil, turf, gravel, sand, sandy soil, silt, clay, loam, mud, red earth, 'sudde', black cotton soil, soft shale, loose moorum and all soils having soil dry density less than 1.80 gm/cc. (IS :1498-1970) copy enclosed vie Annexure 2-A.1, removal of gravel and/or any modular material having diameter in any one direction not exceeding 75 mm occurring in such strata etc.

b) Hard and dense soil - All soils classified in soil groups as per IS : 1498-1970 (Annexure 2-A.1) other than what is covered in (a) above; gravel, cobblestone, hard shale, soft laterite, or any other nodular material having max. diameter in any one direction between 75 mm & 300 mm., ; soft Conglomerate, where the stone can be detached from the matrix with pick axes and shovels. This includes soling of roads, paths etc., and hard core, stiff heavy clay, hard shale or compact moorum requiring grafting tool or pick or both and shovel closely applied. Any material , which requires the close application of picks or scarifies to loosen and not affording resistance to digging greater than the hardest of any soil, mentioned above.

a) Ordinary or soft rock

(i) rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone etc., which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting ;

(ii) macadam surfaces such as water bound and bitumen/tar bound; compact moorum or stabilised soil requiring grafting tool or pick or both and shovel, closely applied ;

(iii) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and

(iv) boulders which do not require blasting having maximum dimension in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

Ordinary rock does not require blasting, wedging or similar means. It may be required a split with crow bars or picks. If required blasting may be resorted to, for loosening the materials but this does not be any way entitle the material to be classified as 'Hard Rock'.

b) Hard rock - Any rock (excluding laterite and hard conglomerate) or boulder for the excavation of which the use of mechanical plant and/or blasting is required; reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level.

Hard rock require blasting but where blasting is prohibited for any reason, excavation has to be carried out by chiseling, wedging or any other agreed method.

c) Marshy soil - This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

2.2 Authority for classification - The engineer shall decide the classification of excavation and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered, as a reason for higher classification unless blasting is clearly necessary in the opinion of the engineer.

2.3 Types of excavation

2.3.1 Surface excavation - Excavation exceeding 1.5 m in width and 10 sq. m on plan but not exceeding 30 cm in depth in all types of soils and rocks shall be described as surface excavation.

Measurements: The length and breadth shall be measured with steel tape correct to the nearest cm and the area worked to the nearest two places of decimal in square metres.

2.3.2 Rough excavation and filling - Excavation for obtaining earth from borrow pits, cutting hillside slopes etc., shall be described as rough excavation. 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 case of hill side cutting, where the excavated materials are thrown down the hill slopes, payment for filling excavated earth shall not be admissible.

2.3.3 Excavation over area (All kinds of soils) - This shall comprise :

a) Excavation exceeding 1.5 m in width and 10 sq. m. on plan and exceeding 30 cm in depth.

b) Excavation for basement, water tanks etc.

c) Excavation in trenches exceeding 1.5 m in width and 10 sq. m. on plan.

2.3.4 Excavation over area (ordinary/hard rock) - This shall comprise:

a) Excavation exceeding 1.5 m in width and 10 sq. m. on plan and exceeding 30 cm in depth.

b) Excavation for basements, water tanks etc.

c) Excavation in trenches exceeding 1.5 m in width and 10 sq. m. on plan.

2.3.5 Excavation in trenches for foundations and drains (all kinds of soil) - This shall comprise excavation not exceeding 1.5 m in width or 10 sq. m. on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.

2.3.6 Excavation in trenches for foundation and drains (ordinary/hard rock) - This shall comprise excavation not exceeding 1.5 m in width or 10 sq. m. on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

2.3.7 Excavation in trenches for pipes, cables etc. refilling - This shall comprise excavation not exceeding 1.5 mts. In width or 10 sq. m. in plan and to any depth in 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.

2.3.8 Width of trench :

a) Upto one metre depth, the authorised 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 authorised width shall be the external diameter of the pipe (not socket/collar) plus 25 cm or the width of concrete bed/cushioning layer whichever is more.

b) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorised 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 upto a depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom.

c) 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.

d) 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. It shall be the responsibility of the contractor to take complete instructions in writing from the engineer regarding

increase in the width of trench, sloping or shoring to be done for excavation in soft, loose or slushy soils.

2.4 SPECIFICATIONS FOR PROTECTION DURING EXCAVATION - Excavation where directed by the engineer shall be securely fenced and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights during the night to avoid accidents.

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 & 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.

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 for which payment shall be made separately.

2.5 SPECIFICATIONS FOR BAILING / PUMPING OF WATER - All water that may accumulate in excavation during the progress of work from rains, subsoil water, springs or any other cause shall be bailed, pumped out or otherwise removed. The foundations shall be kept dry during excavation and laying of foundations. Pumping shall be done directly from the foundation trenches or from a sump outside the excavation as necessary 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. No pumping shall be allowed during laying of concrete or masonry and for a period of at least 24 hours thereafter unless it is done from a suitable sump separated from concrete or masonry by effective means. Pumping shall be done in such a way as not to cause damage to the work or adjoining property by blows, subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

2.6 SPECIFICATIONS FOR SITE CLEARANCE - Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metre above ground level and rubbish removed upto a distance of 50 metres outside the periphery of the area under clearance. The roots of tress and saplings shall be removed to a depth of 60 cm below ground level or 30 cm below formation level or 15 cm below subgrade level, whichever is lower, and the holes, or hollows filled up with the earth, rammed and leveled.

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 is obtained in writing. The roots of tress shall also be removed. Payment for cutting such trees and removing the roots shall be made separately.

Existing Structures and service such as old buildings, culverts, fencing, water supply pipe lines, sewers, power cables, communication cables, drainage pipes, etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the engineer and payment for such diversion/dismantling works shall be made separately.
In case of archaeological monuments within or adjacent to the area, the contractor shall provide necessary fencing alround such monuments as per the directions of the engineer and protect the same properly during execution of works. Payment for providing fencing shall be made separately.

2.7 SPECIFICATIONS FOR SETTING OUT AND MAKING PROFILES - A masonry pillar to serve as a bench mark will be erected at a suitable point in the area, which is visible from the largest area. This bench mark shall be constructed as per Fig.1 and connected with the standard bench mark as approved by the engineer. Necessary profiles with strings stretched on pegs, bamboos or 'Burjis' shall be made to indicate the correct formation levels before the work is started. The contractor shall apply labour and material for constructing bench mark, setting and making profiles and connecting bench mark with the standard bench mark at his own cost. The pegs, bamboos or ' Burjis' and the benchmark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

The ground levels shall be taken at 5 to 15 metres intervals (as directed by the engineer) 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 metres to one cm or any other suitable scale decided by the engineer. North direction line and position of benchmark shall invariably be shown on the plans. These plans shall be signed by the contractor and the engineer or their authorised representatives before the earthwork is started. The labour required for taking levels shall be supplied by the contractor at his own cost.

2.8 SPECIFICATIONS FOR EXCAVATION IN ALL KINDS OF SOILS

2.8.1 All excavation operations 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 atleast one metre or half the depth of excavation, whichever is more, clear off the edge of 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 items of excavation stating lead.

2.8.2 During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.

2.8.2.1 In firm soils, the sides of the trenches shall be kept vertical upto a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can 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 sides sloped or the soil shored up as directed by the engineer. It shall be the responsibility of the contractor to take complete instructions in writing from the engineer regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.

2.8.3 The excavation shall be done true to levels, slope, shape and pattern indicated by the engineer. Only the excavation shown on the drawings or as required by the engineer shall be measured and recorded for payment. In case of excavations the excavations as carried out shall be measured but payment restricted to what is permissible as per approved drawings and as directed by the engineer.

2.8.4 In case of excavation for foundations in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the engineer, 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.

2.8.5 While carrying out the excavation for drain work, care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the engineer, 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 is 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.

2.8.6 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 in with earth duly watered, consolidated and rammed.

2.9 SPECIFICATIONS FOR FILLING EXCAVATED EARTH IN FOUNDATION TRENCH, IN PLINTH AND UNDER FLOOR ETC

2.9.1 Earth - The earth used for filling shall be free from salts, organic or other deleterious matter. Highly expensive soils like black cotton soil shall not be used, unless so specified. All clods of earth exceeding 50 mm shall be broken or removed. Earth obtained from

borrow pits and surplus earth from excavation, if any, shall be directly used for filling and double handling avoided.

2.9.2 Filling sides of trenches - As soon as the work in foundation has been completed and measured, the space around the foundation masonry in trenches shall be cleared of all debris, brickbats, etc., and filled with earth in layers not exceeding 250 mm, each layer being watered, rammed and compacted before the succeeding one is laid. Earth shall be rammed with iron rammer where feasible and with the butt ends of crowbar where rammer cannot be used.

2.9.3 Filling plinth, under floor and hardstanding etc - Filling shall be started from the lowest level in regular horizontal layers each not exceeding 250 mm in depth. Each layer shall be compacted by ramming with rammers of 7 to 10 kg weight. Earth filling shall be adequately watered for achieving maximum compaction.

2.9.4 Special care shall be taken to compact the filling at the junction of the floors with walls and columns. The top surface of the filling shall be neatly dressed level or to a slope or grade as directed.

2.9.5 In large floors, like factory floors, hangars, hardstanding, etc., where indicated, each layer of earth filling shall be compacted by the mechanical means such as sheep foot roller or by hand roller or by power roller to 90 to 95 per cent of standard Proctor's density under optimum moisture conditions.

2.9.6 Filling in trenches for pipes, drains, cables, etc material for filling

2.9.6.1 Earth used for filling shall be free from salts, organic or other deleterious matter. All clods of earth exceeding 50 mm shall be broken or removed. Unless otherwise indicated, where the excavated material is mostly rock, the rock fragment shall be broken into pieces not bigger than 150 mm size and mixed with fine material consisting of decomposed rock moorum or earth as available, so as to fill up the voids as for as possible and then the mixture used for filling.

2.9.7 Filling trenches - Filling in trenches for pipes and drains shall be commenced only after the joints of pipes and drains have been tested and passed by the engineer in writing.

2.9.8 Where the trenches are excavated in soil, the filling shall be done with earth on both the sides simultaneously and on top of pipes in layers not exceeding 250 mm thick, watered, rammed and compacted; taking care that no damage is caused to the pipe below.

2.9.9 In case of excavation in rock, the filling up to a depth of 300 mm above the crown of pipe shall be done with fine material such as earth, moorum, or pulverized decomposed

rock according to the availability at site, in the same manner as described for trenches excavated in soil. The remaining filling shall be done with rock fragments mixed with fine material as available to fill up the voids, watered, rammed and compacted, in layers not exceeding 250 mm thick. Particular care shall be taken in a back filling to avoid future troubles from bursts and leakage due to differential settlement.

2.10 SPECIFICATIONS FOR MOORUM AND SAND FILLING IN FOUNDATIONS, PLINTH AND IN FLOORS

2.19.1 Moorum - Moorum shall be obtained from approved pits and quarries of disintegrated rocks, which contain silicon material, and natural mixture of clay of calcareous origin. These shall not contain any admixture of ordinary earth. Size of moorum shall vary from dust to 40 mm gauge.

2.10.2 Sand - Sand shall be clean, free from dust, organic and other extraneous matter. It shall not contain more than 5 percent of clay/silt.

2.10.3 Shingle - Shingle shall be clean and free from foreign matter and obtained from river or nullah beds. Shingle of all in size ranging from 40 mm down to 4.75 mm gauge shall contain a sufficient proportion of fine material to fill all interstices and ensure binding when consolidated.

2.10.4 Filling - Filling shall be done in a manner similar to earth filling in plinth except that thickness of individual layer shall not exceed 15 cm. Shingle or ballast filling shall be blinded with earth before ramming/consolidation. The surface of the compacted moorum, sand or shingle shall be dressed to the required level, grade or slope. In the case of moorum and sand filling, surface shall be flooded with water for at least 24 hours, surface allowed drying and then compacted and graded.

2.10.5 When the filling in floors etc., has nearly dried, any developing cracks shall be tapped and a thin layer of the same material as used for filling and earth in case of shingle filling shall be spread over the surface evenly and tapped in.

2.11 Measurements

20.11.1 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 5mm, 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 metres.

2.11.2 In case of the ground is fairly uniform and where the site is not required to be leveled, the engineer 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 deadmen, the position of which shall be fixed by the engineer, 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 deadmen shall be made from the measurements unless the same are required to be removed later on and earth so removed is utilised in the work. In the later case nothing extra will be paid for their removal as subsequent operation.

2.11.3 Where ordinary rock and hard rock is mixed, the measurement of the excavation shall be made. 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 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 engineer stacking is not feasible, the quantity of ordinary and hard rock shall be worked out by means of cross-sectional measurements.

2.11.4 Where soil, ordinary rock and hard rock are mixed, the measurements for the entire excavation shall be made. 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 under 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 soil or hard soil as the case may be.

2.11.5 Where it is not possible or convenient to measure the depth of cutting by recording levels, 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 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 at optimum moisture content, or when the consolidated filling is in confined situations such as under floors.

2.12 Rates - Rates for earthwork shall include the following

a) Excavation and depositing excavated material as specified.
b) Handling of antiquities and useful material as specified.
c) Protection as specified.
d) Site clearance as specified.
e) Setting out and making profiles as specified.
f) Forming (or leaving) deadmen or 'Tell Tales' in borrow pits and their removal after measurements.
g) Bailing out or pumping over water from excavations.
h) Initial lead of 50 m and line 1.5 m.
i) Blasting operations for having rock as specified.

2.13 SPECIFICATIONS FOR PLANKING AND STRUTTING

2.13.1 When the depth of trench is soft/l loose soil exceeds 2 metres, stepping sloping / 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 according to the nature of soil.

2.13.1.1 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. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches from collapse. engineer should take guidance from IS : 3764 for designing the
shoring and strutting arrangements for specifying the profile of excavation.

2.13.2 Close planking and strutting

2.13.2.1 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 250 x 38 mm in section or as directed by the engineer.

2.13.2.2 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 walling of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by engineer. The length and diameter of the ballic strut depend upon the width of the trench.

2.13.2.3 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.

2.13.2.4 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 to be left permanently in position.

2.13.3 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 size of the timber and the distances apart shall be subject to the approval of the engineer. In all other respects, SPECIFICATIONS for close planking and strutting shall apply to open planking and strutting.

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

Works shall be grouped according to the following :
a) Depth not exceeding 1.5 m.
b) Depth exceeding 1.5 m in stages of 1.5 m.

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 butt joined sheeting is necessary as in case of running sand the item shall be measured separately and packing of cavities behind sheeting with suitable material included with the item.
e) Planking and strutting required to be left permanently in position shall be measured separately.

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

2.14 SPECIFICATIONS FOR EXCAVATION IN WATER, MUD OR FOUL POSITION

2.14.1 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 acquifier shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and / or pumping out water 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 mortar. During laying of concrete or masonry and for a period of atleast 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

2.14.2 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.

2.14.3 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.

2.14.4 To prevent slipping of sides, planking and strutting may also be done with the approval of the engineer.

2.14.5 Classification - The earth work for various classification of soil shall be categorised as under :

a) Work in or under water and / or liquid mud - Excavation, where water is met with from any of the sources as specified 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 sources, shall fall in this category. Decision of the engineer whether the work is in foul position or not, shall be final.

2.14.6 Measurements - The unit, namely, metre 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. Metre depth shall be

reckoned correct to 0.1 m., 0.05 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.

Pumping or bailing out water met within excavations from the sources as specified where envisaged and specifically ordered in writing by the engineer 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 writing.

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

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.

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

2.15 SPEICIFICATIONS FOR SURFACE DRESSING OF GROUND

2.15.1 Surface dressing shall include cutting and filling upto a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metre above the ground level and the removal of rubbish and

other excavated material upto a distance of 50 metres outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depressions filled upto the required level with the excavated earth so as to given an even, neat and tidy look.

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

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

2.16 SPEICIFICATIONS FOR JUNGLE CLEARANCE

2.16.1 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 metre above the ground level. Where only clearance of grass is involved it shall be measured and paid for separately.

2.16.2 Uprooting of vegetation - 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 subgrade 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, cables 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.

2.16.3 Stacking and disposal - All useful materials obtained from clearing and grubbing operation shall be stacked in the manner as directed by the engineer. Trunks and branches of trees shall be cleared of limbs and tops and stacked neatly at places indicated by the engineer. The materials shall be the property of the Government. All unserviceable materials, which in the opinion of the engineer 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.

2.16.4 Clearance of grass - Clearing and grubbing operations involving only the clearance of grass shall be measured and paid for separately and shall include removal of rubbish up to a distance of 50 m outside the periphery of the area under clearance.

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

2.16.6 Rates - The rates include cost of all the operations described above.
Note : Jungle clearance and clearance of grass are not payable separately for the earthwork as specifiedin 2.3, 2.8 & 2.9.

2.17 SPEICIFICATIONS FOR FELLING TREES

Felling

2.17.1 While clearing jungle, growth trees above 30 cm girth (measured at a height of one metre above ground level) to be cut, shall be approved by the engineer and then marked at site. Felling trees shall include taking out roots up to 60 m below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower.

2.17.2 All excavations 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 surface 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.

2.17.3 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 up to a lead of 50 m.

2.17.4 All unserviceable material, which in the opinion of engineer cannot be used or auctioned shall be removed from the area and disposed off as per the directions of the engineer. 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.

2.17.5 Measurements - Cutting of trees above 30 cm in girth (measured at a height of one metre above ground 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.

2.17.6 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.

2.18 SPECIFICATIONS FOR EXCAVATION IN ORDINARY / HARD ROCK

2.18.1 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 metre or half of depth of excavation, whichever is more, clear off the edge of 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.

2.18.2 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.

2.18.3 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the engineer in writing for resorting to the blasting operations. Blasting operations shall be done as specified 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 and nothing extra shall be payable for chiseling.
2.18.4 Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiseling or by such other methods prescribed by engineer.

2.18.5 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 and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the engineer in writing but nothing extra shall be paid for this blasting.

2.18.6 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, the excess depth shall be made good by the contractor at his own cost with the 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.

2.18.7 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.

2.18.8 In case the excavation is done wider than that shown on the drawings or as required by the engineer, filling wherever required on this account shall be done by the contractor at his own cost.

2.18.9 Only the excavation shown on the drawings or as required by the engineer 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 is satisfied that the contractor has not gone deeper than what was unavoidable.

2.19 SPECIFICATIONS FOR BLASTING

2.19.1 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the engineer in writing for resorting to blasting operation.

Note : In ordinary rock blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the engineer, but nothing extra shall be paid for such blasting operations.

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, 1884 as amended upto date and Explosive Rules, 1983. The contractor shall purchase the explosive fuses, detonators, etc. only from a licensed dealer. Transportation and storage of explosive at site shall conform to the aforesaid Explosive Act and Explosive Rules. The contractor shall be responsible for the safe custody and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The engineer or his authorised 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.

SECTION 4
CONCRETE WORK

4.0 The concrete can be designed in grades denoting **by volumetric proportion of the constituents' characteristic compressive strength. The concrete by volumetric proportion or nominal mix concrete** of the constituents as well as **design mix** denoting compressive strength as detailed in this section.

4.1 Material

4.1.1 Water, cement, lime, fine aggregate or sand, surkhi, cinder and fly ash shall be as specified in Section 0.

4.1.2 Coarse aggregate

4.1.2.1. General - 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. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved / authorised sources

a) Stone aggregate -It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating, injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. It shall conform to IS - 383 unless otherwise specified.

b) Gravel - It shall consists 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. Pit gravel shall be washed if it contains soil materials adhering to it. These shall soil materials soil materials adhering to it. these shall conform to IS - 383 unless otherwise specified.

c) Brick aggregate - Brick aggregate shall be obtained by breaking well burnt or overburnt dense bricks / brick bats. They shall be homogenous 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 deleterious substances. Such aggregate should not contain more than one percent of sulphates and should not absorb more than 10% of their own mass of water, when used in cement concrete and 20% when used in lime concrete. It shall conform to IS - 383 unless otherwise specified.

d) Lightweight aggregates such as sintered fly ash aggregate may also be used provided the engineer is satisfied with the data on the proportion of concrete made with them.

4.1.2.2 Deleterious material - Course aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, shale or similar laminates 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 alkali of cement shall not be used. The maximum quantity of deleterious material shall not more than five per cent of the weight of coarse aggregate when determined in accordance with IS - 2386 part II.

4.1.2.3. Size and grading

(i) Stone aggregate and gravel - It shall be either graded or single sized as specified. Normal 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 prescribed in Annexure 4 -A.1. and shall be in accordance with Table 1.

Table 1 -Graded stone aggregate

IS Sieve Designation	Percentage passing (by weight) for nominal size of			
	40 mm	20 mm	16 mm	12.5 mm
75 mm	100	-	-	-
37.5 mm	95 to 100	100	-	-
19 mm	-	95 to 100	100	100
16 mm	-	-	90 to 100	-
11.2 mm	-	-	-	90 to 100
9.5 mm	10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm	0 to 5	0 to 10	0 to 10	0 to 10
2.36 mm	-	-	-	-

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(b) Normal 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 size the proportion of other sizes as determined by the method prescribed in Annexure 4-A.1 shall be in accordance with Table 2.

Table 2 -Single sized (ungraded) stone aggregate or gravel

IS Sieve Designation	Percentage passing (by weight) for nominal size of					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
75 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-
37.5 mm	0-30	85-100	100	-	-	-
19 mm	0-5	-20	85-100	100	-	-
16 mm	-	-	-	-85-100	100	-
11.2 mm	-	-	-	-	85-100	100
9.5	-	0-5	0-20	0-30	0-45	85-
100						
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

[c] When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sizes 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 the method prescribed in Annexure 4 – A .1 shall be in accordance with Table 1. 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.

Table 3 -Single sized (ungraded) stone aggregate or gravel

Cement Concrete	Nominal size of graded aggregate required	Parts of single size aggregate of size				
		50 mm	40 mm	20 mm	12.5 mm	10 mm

1 –6 -12	63	9	-	3	-	-
1 –6 -12	40	-	9	3	-	-
1 –5 -10	63	7 ½	-	2 ½	-	-
1 –5 -10	40	-	7 ½	2 ½	-	-
1 -4 -8	63	6	-	2	-	-
1 -4 –8	40	-	6	2	-	-
1 -3 –6	63	4 ½	-	1 ½	-	-
1 -3 –6	40	-	4 ½	1 ½	-	-
1 -3 –6	20	-	-	4 ½	-	-
1 -2 –4	40	-	2 ½	1	-	½
1;2 –4	20	-	-	3	-	1
1 -2 –4	12.5	-	-	-	3	-
1 -1 ½ -3	20	-	-	2	-	1

Note -(i) The proportions indicated in Table 3 above are by volume when considered necessary, these proportions may be varied marginally by engineer 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. If single size coarse aggregates are not premixed at site to obtain the graded coarse aggregate required for 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 be40 mm and its grading shall be as specified in the Table 4 when tested for sieve analysis by the method prescribed in Annexure 4 – A .1.

Table 4 -Brick aggregate

IS Sieve Designation(by weight)	Percentage passing
75 mm	100
37.5 mm	95-100
19.0 mm	45-100
4.75	0-5

Note -Coarse aggregate for cement concrete shall generally conform to para 4.2.1 of IS - 456 and fine aggregate shall conform to IS - 383.

4.1.2.4. 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.

4.1.2.5. Testing - Coarse aggregate shall be tested for the following (as per IS - 2386)

(a) Determination of particle size and shape(Annexure 4 – A.1)

(b) Estimation of organic impurities (as per IS - 2386-Part II)
(c) Surface moisture (Annexure 4 – A.2)
(d) Determination of 10% fine value (Annexure 4 – A.3)

4.1.2.6. 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 aggregates nominal size below 40 mm.

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

4.2. SPECIFICATIONS FOR CEMENT CONCRETE

4.2.0. This shall be prepared by mixing graded stone or brick aggregate of nominal size as specified with fine aggregate and cement in specified proportions with required quantity of water. The grading and quality of aggregates shall be such as to give minimum compressive strength of 140 kg/cm² and 210 kg / cm² at 7 days and 28 days respectively in case of mix 1 -2 -4, (One cement - two Coarse sand - four stone aggregate).

One sample consisting of 6 cubes 15x15x15 cm shall be taken for every 15 cubic metre or part thereof cement concrete 1 -2 -4. The cube tests shall not be carried out in case the quantity of cement concrete placed on any day is less than 15 cubic metre unless otherwise specific. For other details, refer section on R.C.C. work.

4.2.1. Proportioning - It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally 35 X 25 X40 cm deep or as otherwise approved by the engineer. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cubic metre. 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 bulkage shall be made as given for mortar.

4.2.2. Preparation - This shall be prepared by mixing coarse aggregate, fine aggregate and cement in specified proportions with required quantity of water. Nominal size and quality of aggregate shall be as specified.

Except where brick aggregate is used in cement concrete, minimum compressive strength on works test for different concrete mixes shall be as specified for various grades prepared by volume basis, in Table 5 below. The work test shall be carried out for every 15 cum of a day's concreting unless otherwise specified.

Table 5

Concrete mix	Min compressive strength on15 cm cube in Kg / cm²	
	7 days strength	28 days strength

1 -1 -2	210	315
1 -1½ -3		265
1 -2 -4	140	175

4.2.2.1. Mixing - Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS - 1791 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 writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a watertight 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. For guidance, the mixing time may be 1½ to 2 minutes, for hydrophobic cement it may be taken as 2½ to 3 minutes.

4.2.2.2. Power loader - Mixer will be fitted with a power loader complying with the following requirements.

a) The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

Note - In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

b) The minimum inside width of the feeding edge of the hopper shall be as specified below in Table 6.

Table 6

Nominal size of mixer (T, NT or R), litre	Minimum inside width of hopper feeding edge in mm
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0

T = tilting; NT = non-tilting; R = Reverse

c) The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the center line of the chute plate of the hopper when in discharge position, is at an angle of not less than 50º to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be

provided. Even when a mechanical device is provided, it is recommended that the angle of center line of the chute plate of the hopper when in discharge position, should be as large as practicable, preferably not less than 40º to horizontal.

d) When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, there should be at least one and half drums of rope on the drum.

e) Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.

f) The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.

g) Safety device shall be provided to secure the hopper in raised position when not in use

4.2.2.3. Mixing efficiency - 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 halves of the batch shall not be more than the following limits -

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

4.2.2.4. Machine mixing - 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 atleast 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. 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 atleast 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 clean with water.

4.2.2.5 Hand mixing - When hand mixing has been specifically permitted in exceptional circumstances by the engineer 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 shoveling and turning till the coarse aggregate gets evenly distributed in the cement sand mixture. Three quarter 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 it 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.

4.2.3. Workability - The quantity of water to be used for each mix shall be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means specified. Generally, the quantity of water to be used for each mix of 50 Kgs cement shall not be more than 34 litres for 1 -3 -6 mix, 30 litres for 1 -2 -4 mix, 30 litres for 1 -1½ -3 mix and 25 litres for 1 -1 -2 mix. In case of vibrated concrete, the quantity of water may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests as described in annexure 4.A.4. The slump and workability for different kind of works shall be as per table 7 below

Table 7

Placing conditions.	Degree of workability	Value of workability
Concreting of shallow Sections with vibration	Very low	0.75-0.80 Compacting factor.
Concreting of lightly reinforced reinforced section with vibration.	Low	Slump up to 25 mm, 10-5 Seconds, vee bee time 0.8-0.85 compacting factor.
Concreting of lightly reinforced section without vibration or heavily reinforced sections with vibration.	Medium	25-75 mm, slump for 20 mm aggregate.
Concreting of heavily reinforced sections without vibration.	High	75-125 mm slump for 20 mm aggregate.

Note - Where considered necessary, the workability of the concrete my also be ascertained by compacting factor test and vee-bee censistometer method as specified in IS - 1199. For suggested ranges of value of workability of concrete by the above methods, reference may be made to IS - 456-2000.

4.2.4. Transportation - 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.

4.2.5. Placing - The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) 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.

4.2.6. Compaction - 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 specifications for concrete vibrators (immersion type). To prevent segregation, over vibration shall be avoided. The use of mechanical vibrator may be relaxed by the engineer at his discretion for certain items and permit hand compaction. Hand compaction shall be done with the help of tamping rods. 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 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.

4.2.7. Construction joints - Connecting shall be carried out continuously upto construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the engineer. Number of such joints shall be kept minimum. oints shall be kept as straight as possible.

4.2.7.1. 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 2kgs. of cement per sq m 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

4.2.7.2. 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 per sqm. On this surface, a layer of concrete not exceeding 150 mm in

thickness shall first be placed and shall be well rammed against corners and close spots; work, thereafter, shall proceed in the normal way.

4.2.8. Concreting under special conditions

4.2.8.1 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) and IS - 7861(Part II) respectively. Concreting shall not be done when the temperature falls below 4.5º 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 38ºC.

4.2.8.2 Under water concreting - Concrete shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. The concrete shall contain at least 10% more cement than that required for the same mix placed in dry conditions, the quantity of extra cement varying with conditions of placing with prior written permission of the engineer. Such extra cement will be paid extra. The volume of coarse aggregate shall not be less than 1½ times nor more than twice the fine aggregate and slump not less than 100 mm nor more than 180 mm. Where found necessary to deposit any concrete under water, the method, equipment, materials and mix shall first be got approved by the engineer. Concrete shall be deposited continuously until it is brought to required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of heaps shall be avoided. The concrete shall be deposited under water by one of the approved methods such as tremie method, drop bottom bucket, bags, grouting etc. as per details given in IS - 456-2000. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way

4.2.9. Curing - When the concrete begins to harden i.e. two to three hours after compaction, the exposed surfaces shall be kept damp with moist gunny bags, sand or any other material approved by the engineer 24 hours after compaction, the exposed surface shall be kept continuously in damp or wet conditions by ponding or by covering with a layer of sacking, canvass, hessian or similar absorbent materials and kept constantly wet for atleast 7 days where ordinary portland cement is used and 10 days, where portland pozzolona cement is used from the date of placing of concrete. For concrete work with other types of cement, curing period shall be as directed by the engineer.

Approved curing compounds may be used in lieu of moist curing with the permission of the engineer. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set

4.2.9.1 Freshly laid concrete shall be protected from rain by suitable covering.

4.2.9.2 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 atleast 7 days. And where cement concrete is used as

base concrete for flooring, the flooring may be commenced before the curing of period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

4.2.10. Testing of concrete will be done as described in section on R.C.C

4.2.11. From work - Form work shall be as specified in R.C.C section and shall be paid for separately unless otherwise specified.

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

4.2.13. Measurements

4.2.13.1. 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. Area shall be worked out to nearest 0.01 square metre and the cubic contents of consolidated concrete shall be worked out nearest 0.001 cubic metres. Any work done in excess over the specified dimension or as required by engineer be ignored.

4.2.13.2. Concrete work executed in the following conditions shall be measured separately -

a. At or near the ground level
b. Work in liquid mud
c. Work in or under foul positions

4.2.13.3. Cast-in-situ concrete and or precast concrete work shall be measured in stages described in the item of work, such as -

a. At or near the ground level
b. Upto specified floor level
c. Between two specified floor levels
d. Upto specified height above or depth below plinth level/ defined datum level
e. Between two specified heights or depths with reference to plinth level / defined datum level

4.2.13.4. No deduction shall be made for the following -

a. Ends of dissimilar materials for example beams, girders, rafters, purlins trusses corbels and steps upto 500sq in cross sections.
b. Opening upto 0.1sq metre (1000sq.cm).
c. Volume occupied by pipes, conduits, sheathing etc. not exceeding 100sq cm each in cross sectional areas.
d. Small voids such as shaded portions in Figure when these do not exceed 40sq cm each in cross section.

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

4.2.13.5. Cast-in-situ concrete shall be classified and measured as follows -

a) Foundation, footings, bases for columns
b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.
c) Shelves
d) Slabs
e) Chajjas including portions bearing on the wall
f) Lintels, beams and bressummers
g) Columns, piers abutments, pillars, post and struts
h) Stair case including stringer beams but excluding landings.
i) Balustrades, newels and sailing
j) Spiral staircase (including landing)
k) Arches
l) Domes, vaults
m) Shell roof, arch ribs and folded plates
n) Chimneys and shaft.
o) Breast walls, retaining, walls, return walls
p) Concrete filling to precast components
q) Kerbs, steps and the like
r) String or lacing courses, parapets, copings, bed block,anchor blocks, plian window sills and the like
s) Cornices and moulded windows sills.
t) Louvers, fins, facia.

4.6 SPECIFICATIONS FOR REINFORCED CEMENT CONCRETE WORK

4.6.0. General - Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by engineer according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

a) Form work (Centring and shuttering)
b) Reinforcement
c) Concreting - 1) Cast-in-situ 2) Precast

4.6.1 Materials

4.6.1.1 Water, cement, fine and coarse aggregate shall be as specified under respective clauses of mortars and section 04-concrete work as applicable.

4.6.1.2 Steel for reinforcement

4.6.1.2.1 The steel used for reinforcement shall be any of the following types -

a) Mild steel sand medium tensile bars conforming to IS -432 (part I)
b) Hard drawn steel write conforming to IS -432 (part II)

High strength deformed steel bars conforming to IS - 1786

c) Hard drawn steel wire fabric conforming to IS - 1566
d) Structural steel section conforming to IS - 2062 - 1999

4.6.1.2.2 Types and grades - Reinforcement supplied in accordance with this standard shall be classified into the following types -

a) Mild steel bars - It shall be supplied in the following two grades
i) Mild steel bars grade I designated as Fe 410-S
ii) Mild steel bars grade II designated as Fe 410-O.

b) Medium tensile steel bars, grade II designated as Fe-540-W-HT.

4.6.1.2.3 Mild steel and medium tensile steel - Physical requirement are given in the following Table 11

Table 11

Sl No	Type and nominal size Of bars	Ultimate tensile stress N/mm^2 minimum	Yield stress N/mm^2 minimum	Elongation Percent
1	Mild steel grade I For bars upto and including 20 mm	410	250	23
	For bars over 20 mm upto and Including 50 mm	410	240	23
2	Mild steel grade I For bars upto and including 20 mm	370	225	23
	For bars over 20 mm upto and Including 50 mm	370	215	23
3	Medium tensile steel For bars upto & including 16 mm	540	350	20
	For bars over 16 mm, upto And including 32 mm	540	340	20
	For bars over 32 mm, upto And including 50 mm	510	330	20

Elongation percent on gauge length 5.65 $\sqrt{so}$ where so is the cross section area of the test piece.

Note - 1. Grade (II) Mild steel bars are not recommended for the use in structures located in the earthquake zone subjected to serve damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.
2. Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS - 2751.

Nominal mass / weight - The tolerance on mass / weight for round and square bars shall be the percentage given in Table. 12 of the mass / weight calculated on the basis that the masses of the bar / wire of nominal diameter and of density 0.785 kg / cm^3 or 0.00785 kg / mm^3.

Table 12

(Tolerance on nominal mass)

Nominal size In mm	Tolerance on the nominal mass percent		
	Batch	Individual Sample +	Individual sample for coil(-x-)
a) upto and including 10	± 7	± 8	± 8
b) over 10, upto and including 16	+5	-6	+6
c) over 16	± 3	-4	± 4

+ for individual sample plus tolerance in not specified

(x) for coil batch tolerance is not applicable

Tolerance shall be determined in accordance with method given in IS 1786-1985

Tests - Following type of lab test shall be carried out

1) Tensile test - This shall be done as per IS 1608
2) Bend test - This shall be done as per IS 1599
3) Re-test - This shall be done as per IS 1786
4) Rebend test -This shall be done as per IS 1786

Should any one of the test pieces first selected fail to pass any of the tests specified above, two further samples shall be selected for testing in respect of each failure. Should the test pieces from both these additional samples pass, the materials represented by the test samples shall be deemed to comply with the requirement of the particular test. Should the test piece from either of these additional samples fail, the material represented by the test samples shall be considered as not having complied with standard.

High strength deformed bars & wires shall conform to IS -1786. The physical properties for all sizes of steel bars are mentioned below in Table 13.

Table 13

Sl. No	Property	Grade		
		Fe 415	Fe 500	Fe 550
1	0.2% proof Stress/Yield stress,min. N/mm²	415	500	550
	Elongation, percent min. on guage Length $5.65\sqrt{A}$, Where A is the X-sectional Area of the test piece	14.5	12	8
3	Tensile strength	10 % more than actual 0.2 % proof stress but not less than 465 N/mm²	8 % more than actual 0.2 % proof stress but not less than 545 N/mm²	6 % more than actual 0.2 % proof stress but not less than 585 N/mm²

Tests - Selection and preparation of test sample. All the tests pieces shall be selected by the engineer or his authorised representative either-

a) From cutting of bars

or

b) If he so desires, from any after it has been cut to the required or specified size and the test piece taken from 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 or his authorised representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deductions 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.

Tensile test - This shall be done as per IS - 1599.

Re-test - This shall be done as per IS - 1786.

4.6.1.3 Stacking and storage - Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause to minimum wastage in cutting from standard length.

4.6.2 SPECIFICATIONS FOR FORMWORK (CENTRING & SHUTTERING)

4.6.2.1 - 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.

4.6.2.2 - Design & tolerance in construction - Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerances given below.

a)	Deviation from specified dimensions of cross section of columns and beams		+ 12 mm
b)	Deviation from dimensions of footings		+ 12 mm
	i)	Dimension in plan	+ 50 mm
	ii)	Eccentrically in plan	0.02 times the width of the footings in the direction of deviation but not more than 50 mm
	iii)	Thickness	+ 0.05 times the specified thickness.

(Note – Tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels.)

4.6.2.3. **General requirement -** 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.

Forms 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.

4.6.2.3.1 Material for form work

a) Propping and centring - All propping and centring should be either of steel tubes with extension pieces or built up sections of rolled steel.

4.6.2.3.2 Centring/Staging - Staging should be as designed with required extension pieces as approved by engineer to ensure proper slopes, as per design for slabs /beams etc. and as per levels as shown in drawings. All the staging to be either tubular steel structure with adequate bracings as approved or made of built up structural sections made from rolled structural steel sections

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

b) Form work and concreting of upper floor shall not be done until concrete of lower floor has set atleast for 14 days.

4.6.2.3.3. Shuttering - Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberised lining of material as approved by the engineer shall be provided in the joints.

Steel shuttering used for 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 oints RS, 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.

4.6.2.3.4 From 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 centring exceeds 3.50 meters, the prop may be provided in multi-stages. A typical detail of multistage shuttering is given in Fig. 9.

4.6.2.3.5 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) or as directed by the engineer, 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.

4.6.2.3.5.1 Typical arrangement of form work for 'Beams, columns and walls' are shown in Figure 1 to 8 and form secured by wall ties is shown in Fig.3.

4.6.2.3.6. Walls - The forms 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. Some of the accessories used for wall forms.

4.6.2.3.7 Removal of form work (stripping time) - In normal circumstance and where ordinary portland cement is used, forms may generally be removed after the expiry of the following periods -

a) Walls ,columns and faces of all structural members 24 to 48 hours as many be decided by the engineer

b) Slab

i)	Spanning upto 4.50 M	7 days
ii)	Spanning over 4.50 M	14 days

c) Beams and arches

i)	Spanning upto 6 M	14 days
ii)	Spanning over 6 M & Upto 9 m	21 days
iii)	Spanning over 9 M	28 days '

Note 1 - For the other types of cement, the stripping time recommended for ordinary portland cement may be suitably modified. If portland pozzolana or low heat cement has been used for concrete, the stripping time will be 10/7 of the period stated 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 of the slabs, beam or arch as the case may be together with any live load likely to occur during curing of further construction.

Note 3 - For rapid hardening cement, 3/7 of above periods will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for atleast 24 hours.

Note 4 - In case cantilever slabs and beams, the centring 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.

4.6.2.4. Surface treatment

4.6.2.4.1. Oiling the surface - Shuttering gives much longer service life in the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections. A 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 centipoise.

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

4.6.2.4.2 The design of form work shall conform to sound engineering practices and relevant IS codes.

4.6.2.5 Inspection of form work - The completed form work shall be inspected and approved by the engineer before reinforcement bars are placed in position. Proper from work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discolouration 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.

Shuttering surface before concreting should be free from any defect / deposits and fully cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and exclusive roughness before use.

4.6.2.5.1. Erection of form work (centring 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.

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.

d) 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.

e) 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 device and bracing shall be tightened.

f) The stacked materials shall be placed as catered for, in the design.

g) 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 centralising beams placed in the forkheads.

h) Screw adjustment of adjustable props shall not be over extended.

i) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement / elastic shortening 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 their shifting.

j) No member shall be eccentric upon vertical member.

k) The number of nuts and bolts shall be adequate.

l) All provisions of the design and / or drawings shall be complied with.

m) Cantilever supports shall be adequate.

n) Props shall be directly under one another in multistage constructions as far as possible.

o) Guy ropes or stays shall be tensioned property.

p) There shall be adequate provision for the movement and operation of vibrators and other construction plant and equipment.

q) Required camber shall be provided over long spans.

r) Supports shall be adequate, and in plumb within the specified tolerances.

4.6.2.6 Measurements

4.6.2.6.1. General - The form work shall include the following;

a) Splayed edges, notchings, 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) Filling to form stop chamfered edges of splayed external angles not exceeding 20 mm 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 concrete.
g) Dressing with oil to prevent adhesion and
h) Raking or circular cutting.

4.6.2.6.2 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 and precast shelves,
b) Walls (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, girders, bressummers and cantilevers.
e) Columns, pillars, posts and struts.
f) Stairs (excluding landing) except Spiral staircase.
g) Spiral staircase (including landing).
h) Arches.
i) Domes, vaults, shells roofs, archribs and folded plates.
j) Chimneys and shafts.
k) Well steining.
l) Vertical and horizontal fins individually nor forming box, louvers and bands.
m) Waffle or ribbed slabs.
n) Edges of slabs and breaks in floors and walls (to be measured in running metres where below 200 mm in width or thickness).
o) Comices and mouldings.
p) Small surfaces, such as cantilevers ends, brackets and end of steps, caps and boxes to pilasters and columns and like.
q) Chullah hoods, weather shades, chajjas, corbels etc. including edges and
r) Elevated water reservoirs.

4.6.2.6.3 Centring, and shuttering where exceeding 3.5 meter height in one floor shall be measure and paid for separately.

4.6.2.6.4 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.

4.6.2.6.5. No deductions from the shuttering due to the openings / obstructions shall be made if the area of such openings / obstructions does not exceed 0.1 square meter. Nothing extra shall be paid for forming such openings.

4.6.2.7 Rate - The rate of the form work includes the cost of labour and materials required for all the operations described above.

4.6.3. SPECIFICATIONS FOR REINFORCEMENTS IN CONCRETE

4.6.3.1 General requirements - Steel conforming to para 4.6.1.2. for reinforcement shall be clear and free from loose milscales, dust, loose rust, coats of paints, oil or other coatings 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 used for removing the rust.

4.6.3.1.1 Assembly of reinforcement - Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by engineer. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Over lapping of bars, where necessary shall be done as directed by the engineer. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25 mm or 1 ¼ 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. But in no case the over lapping shall be more than 50% of cross sectional area at one section.

4.6.3.1.2 Bonds and hooks forming end anchorages - Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice for 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 of the bar

U – Type Hook

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 drawing.

b) Bends - Bend forming anchorage to a M.S. plain bar shall be bent with an 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.

4.6.3.1.3 Anchoring bars in tension - Deformed bars may be used without end anchorages provided, development length requirement is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per clause 25.2.1 of IS - 456-2000.

4.6.3.1.4 Anchoring bars in compression - The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars is compression as specified in of IS - 456-2000. The projected length of hooks, bends and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

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

4.6.3.1.6 Welding of bars - Whenever facility for electric arc 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. Welding shall be as per IS - 2751 for mild steel bars and for cold worked bars.

4.6.3.2 Placing in position

4.6.3.2.1 Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the engineer. The bars crossing one another shall be tied together at every intersection with two stands 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.

Track welding in crossing bars shall also be permitted in lieu of bending with steel wire if approved by engineer.

4.6.3.2.2. The bars shall be kept in correct position by the following methods -

a) In case of beam and slab construction precast cover blocks of cement mortar 1 -2 (1 cement - 2coarse 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 reinforcement.

b) In case of cantilevered and doubly reinforced beams or 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 block of cement mortar 1 -2 (1 cement - 2 coarse sand) of required size suitably tied to the reinforcement to ensure that they are in correct position during concreting.

d) In case of R.C.C. structure such arches, domes, shells, storage tanks etc. a combination of cover blocks, spaces and templates shall be used as directed by engineer.

4.6.3.2.3. Tolerance on placing of reinforcement - Unless otherwise specified by the engineer, reinforcement shall be placed within the following tolerances -

Tolerance in spacing

		Tolerance in spacing
a)	For effective depth 200 mm or less	± 10
b)	For effective depth More than 200 mm	± 15

The cover shall in no case be reduced by more than one third of specified cover or 5 mm which ever is less.

4.6.3.2.4. 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 bars diameters for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bars in not damaged.

4.6.3.3 Measurements - Reinforcement including authorised spacer bars and lappages shall be measured in length of different diameters, 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 – 14 below. Wastage and unauthorised overlaps shall be paid for. Annealed steel wire required for binding or tack welding shall bot be measured, its cost being included in the rate reinforcement.

Wherever 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 and measured separately and paid for.

Table 14

Cross-sectional area and mass of steel bar

Nominal size mm	Cross sectional area sq.mm	Mass per metre run kg
6	28.3	0.222
7	38.5	0.302
8	50.3	0.395

10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
18	254.6	2.00
20	314.3	2.47
22	380.3	2.98
25	491.1	3.85
28	616.0	4.83
32	804.6	6.31
36	1018.3	7.99
40	1257.2	9.85
45	1591.1	12.50
50	1964.3	15.42

Note - These are as per clause 5.2 of IS 1786.

4.6.3.4. 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, as required of directed including tack welding on crossing of bars in lieu of binding with wires.

4.6.4 SPECIFICATIONS FOR CONCRETING

4.6.4.0. The concrete shall be done as specified. The proportion by volume of ingredients shall be as specified.

4.6.4.1 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 n[prescribed in chapter " concrete under para 4.2.3 workability"

4.6.4.1.1 Where considered necessary, the workability of the concrete may also be ascertained by compacting factor test and VEE BEE consistometer method specified in IS - 1199. For suggested ranges of values of workability of concrete by the above two methods, reference may be made to IS - 456.

4.6.4.2 Placing of concrete

4.6.4.2.1. Concreting shall be commenced only after engineer has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shaving, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed in 4.5.2.4

4.6.4.2.2 In case of concreting of slabs and beams, wooden plank or cat walks of chequerred MS plates or bamboo chlies 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.

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

4.6.4.2.4 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 case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete in not more than 1.5 metres at a time.

4.6.4.2.5 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 converting. Concrete damaged by frost shall be removed and work redone.

4.6.4.2.6 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 of the closing time of the day, unless permitted by the engineer.

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

4.6.4.3 Compaction

4.6.4.3.1 Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations. The engineer may however relax this conditions 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 from. 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 deaeration 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.

4.6.4.3.2 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 vibrators. 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.

4.6.4.4 Construction joints

4.6.4.4.1 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 indicated in Fig. 26 or as directed by engineer. 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.

4.6.4.4.2 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.

4.6.4.4.3 When stopping the concrete on a vertical plane in slabs and beams, an approved stop-board (see Fig.26C) 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.

4.6.4.4.4 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.

4.6.4.5 Expansion joints - Expansion joints shall be provided as shown in the structural drawings or as indicated in Fig. 10 to 25 or as directed by engineer, 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 metre. The measurement shall be taken upto two places of decimal stating the depth and width of joint.

4.6.4.6 Curing - After the concrete has begun 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. After 24 hours of laying of concrete, the surface shall be cured of ponding with water for a minimum period of 7 days from the date of placing of concrete.

4.6.4.7 Finishing

4.6.4.7.1 In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set.

4.6.4.7.2 Immediately on removal of forms, the R.C.C work shall be examined by the engineer, 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 4.6.4.9.4 for visual inspection test.

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

1) Surface defects which require repair when forms are removed, usually consist of bulges 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 preferable slightly undercut to provide a key at the edge of the path.

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 10 mm 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 material 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 surface 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.

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

4.6.4.8 Strength of concrete - The compressive strength on work tests for different mixes shall be as given in table 15 below -

Table 15

Concrete mix	Compressive strength in

(Nominal mix on volume basis)	(kg/sq cm)	
	7 days	28 days
1:1:2	210	315
1:1 ½ : 3	175	265
1:2:4	140	210

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

(a) Raft, footing, bases of columns etc. and mass concrete.
(b) walls (any thickness) including attached pilasters, buttresses, plinth and string course, fillets 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 waistless 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 course, 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.

4.6.4.11.4 No deduction shall be made for the following -

(a) Ends of dissimilar materials (e.g. oists, beams post griders, rafters, 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 linthels or sills. No extra labour for forming such opening or voids shall be paid for.

(c) The volume occupied by reinforcement.

(d) The volume occupied by water pipes, conducts etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

4.6.4.11.5 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 bream.

(b) Beams shall be measured from face to face of columns and shall include haunches, if any, between columns and beam. The depth of the bottom of beam shall be from the bottom of slab to the bottom of beam and slabs 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 measurement shall be taken through.

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

4.6.4.12. 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 drawing by the designer. Whenever these are not specified, the permissible tolerance shall be decided by the engineer after consultations with the Designer, if necessary.

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

(a) If the actual dimensions 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 measurements.

(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 dimension of engineer shall be final. For the purpose of payment, however, the clarification as given in para a, b & c above shall apply

4.6.4.13 Rate

4.6.4.13.1. The rate includes the cost of materials and labour involved in all the operations described above except for the cost of centring and shuttering.

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

4.6.4.13.3 Where throating or plaster drip or moullding is not required to be provided in RCC chajjas, deduction for not providing throating or plaster drip or moulding shall be made from the item of R.C.C. In chajjas. The measurement for deduction item shall be measured in running metres direct to a cm of the edge of chajja.

4.6.4.13.4 No extra payment for richer mix which projects into any meter from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawing. The payments for work done under items of different mixes shall be limited strictly to what is indicated in the structural drawings.

SECTION 5
STONE WORK

5.1 Stone

5.1.1 Requirements of a good structural stone - Structural stones should primarily be (a) strong against crushing, (b) durable, (resistance to weather), (c) good in appearance (colour), (d) susceptible of being quarried in large sizes, and (e) fire resisting.

The strength of a stone depends upon its density and weight.

5.1.3 Quality of good stone and comparative strength - A stone of igneous origin is stronger than one of sedimentary formation. Stones with silicates as binding material will weather better than those with calcareous binding material. Generally, crystalline stones are hard and compact and are superior to non-crystalline stones. Finer the crystalline structure, stronger and more durable is the stone. An examination of old structure, where it has been used will indicate durability. If tool marks are visible, the edges or corners are still sharp and true and the surface hard showing no signs of deterioration, the stone may

be regarded as satisfactory. A fresh fracture of good stone, suitable for structural work should be bright, clean and sharp, free from loose grains, and should not have an earthy smell.

For dressing, stone should be comparatively soft, yet durable, compact grained and homogeneous in texture, rather than crystalline, free from veins and planes of cleavage.

The specific gravity of a good stone should not be less than 2.7.

5.1.4 Stones used in building construction - The principal stones used in building construction are granites, gneiss, trap or basalt, quartzites, laterites, schists, lime stones, sand stones, pot stones and slates.

a) Granites - A typical granite contains large proportion of felspar than quartz, mixed with little mica, either the Muscovite or the Biotite variety.

b) Gneiss - A metamorphic rock**.** Gneisses are grouped according to the nature of the dark mineral present in the sample or according to the type of igneous rock to which they are most related. Normal granite is a massive rock without foliation. Normal granite is a massive rock without foliation; when it talks foliated structure subsequent to its crystallisation it is termed gneiss.

c) Trap or Basalt - Both are igneous rocks. Trap contains felspar and hornblende while Basalt, which contains felspar, augite and iron. Both are fine grained. They are very compact, hard and durable stones. They are rather hard to work and obtainable in small sizes and not obtainable in large blocks.

d) Quartzites - Derived from the metamorphosis of sandstones or conglomerates. It is very hard to work and breaks up into irregular sizes and large blocks are not available.

e) Laterites - are claystones with a vesicular texture, the vesicular being impregnated with iron in cellular structure. It is a soft rock suitable for light buildings. It contains moisture (quarry sap) when freshly quarried and is thus very easy to dress at that time. After exposure for a month or two, it becomes harder. It is very easy to work but care is required in selection of stones.

f) Schists - Metamorphic rock belonging to group of foliated rocks. Finer in texture than gneiss. Derived either from igneous or sedimentary rocks. Varieties are named according to the abundance of ferro-magnesium mineral. Chief among the members of this family that are found in this State are hornblende schists, chlorite schists, calcite schists, and mica schists. The rocks are generally dark in colour.

g) Lime stones - are those in which calcium carbonate forms the base.

Sand Stones – are those in which silica constitute the base.

h) Slates - are fine grained compact argillaceous rocks with planes of cleavage, independent of the original beds, often crossing them at a great angle.

j) Pot stones - Impure form of Talc, composition being chiefly silicate of magnesia and is not useful for structural work. It is very easy to work. The best variety is red variety. Mottled and streamed colours pervading it should not be very unevenly distributed. It should not be used in places where it is subjected to any great pressure and liable to be soaked with water.

5.1.5 Ornamental building stones - The following varieties can take fine polish and are mainly used as ornamental building stones

a) Grey rocks - Which include the medium to fine grained and coarse grained granite gneisses and granites. These are useful for decorative purposes and are available from Sarakki quarries and Malsandra quarries near Bangalore.

b) Porphyritic granite - A coarse grained granite having greyish colour with slightly pinkish tinge. The polished surface of the rock gives a mottled appearance with large plates of dull white plagioclase and pale pink orthoclase occurring in a greyish ground mass having quartz and biotite. These are available from certain quarries in Chitradurga District.

c) Pink rocks - This group has been divided into (a) non-porphyritic and (b) coarse porphyritic types, the former occurring near Ramnagaram, Magadi and Chamundi Hills, and the latter near Ilikal and Sivaganga.

d) Green rocks - These rocks are available in Chikmagalur Taluk.

e) Black rocks - Occurs as an outcrop about two miles east of Mysore on the Mysore-Mahadevapur Road. It is compact and soft and takes good and lasting polish.

f) Black trap (Turuvekere Stone) - Occurs in the form of a huge dyke to the east of Kadehalli, a village 6 miles south of Turuvekere. The rock is soft compact and black when fresh. It has a greyish appearance on weathered surface ; Quarries near Banasandra also yield good samples.

g) Felsites and porphyry - Occurring in the form of dykes of quite a great range of texture and colour. Outcrop conspicuously in the Srirangapatnam and Mandya Taluks ; when cut and polished they form ornamental building stones.

h) Marble - It is a compact, crystalline and the strongest and most durable variety of limestone formed by the metamorphic action. It is obtainable in a variety of colours, white, grey, blue, green, yellow. It can be easily sawn and carved ; it takes high polish.

i) Artificial Stones - Processes have been invented for the manufacture of artificial stones for use in localities where natural stones cannot be had. Some of the processes produce of high quality. Comparative cost of producing artificial stones for use in any locality should determine its adoption. The facility with which it can be moulded to most intricate forms, however, makes it more economical than carvings in natural stone.

j) Artificial stones are practically forms of good setting mortar or of concrete.

1) Artificial stone is made by mixing dry sand with silicate of soda (dissolved flint) and a small proportion of powdered stone or chalk. These are thoroughly mixed together in a

pug or mortar mill, and forced by hand into moulds. A cold solution of chloride of calcium is poured over the blocks turned out, which are then immersed in a boiling solution of the same, sometimes under pressure, so as to entirely fill the pores of the material with the solution. After this the blocks are found to be as hard as most building stones. The excess of sodium chloride is washed off to prevent efflorescence. This stone has been used for a variety of purposes.

2) Victoria stone **-** A mixture of four parts of crushed granite with one of Portland cement is allowed to set for three days or more into a hard block moulded to the required shape. It is then immersed in silicate of soda for some seven or eight weeks. This stone also has been used for various purposes.

3) Silicated stone - Is made in the same way as Victoria stone, and used for paving slabs and drain pipes.

4) Artificial paving slabs and paving stones - of many kinds are used nowadays. They are often composed of Portland Cement concrete very carefully made. Silicates are sometimes added to give hardness to the mass.

5.1.6 Quarrying stones - The open part of natural rock, from which useful material is obtained by loosening or blasting or both is called a quarry, and the process, quarrying. There is not much difference between quarrying and mining, except that a quarry is open at surface, whereas mining is done underground.
The quarrying should be done in quarries approved by the Executive engineer and the methods of quarrying should be as per standard procedures.

The rock loosened shall be cut into the required sizes by weight, chisels or butt hammers as per requisitions. Quarry chips shall be removed and stacked separately.

The quarrying for face and cut stones shall be made in selected quarries.

Stones required for dimensioned work to be quarried true and square and as near the dimensions given as possible.

5.1.7 Methods of quarrying - The methods commonly adopted for quarrying stones are as follows :-
1) Quarrying stones
a) by wedging and splitting and
b) by chiselling.

2) Quarrying stones by burning.
3) Quarrying stones by blasting.

Dressing of stones - After quarrying, stones are to be wrought or dressed to varying degrees, depending on the kind of work on which they are used. It is better to do as much dressing as is possible at the quarry.

5.1.8 Dressing of stone is done in three operations.

1) While sorting out stone for different useful purposes such as bases, caps of pillars. Arch stones, corner stones, coping, etc., a stone is roughly hewn with a quarry hammer of about 3kgs, weight to reduce its weight to minimum by knocking out unwanted materials.

2) It is then hauled up and it is given the rough shape (by a mason's hammer of weight 1 to 1.5 Kgs), of a rectangular block for which it was originally sorted out.

3) Final dressing is done on the site of works by tools such as pitching tool, point chisel, plane or toothed chisels .

5.1.8.1 Blocks of stone, which are to be put into the masonry, should be dressed with horizontal beds and vertical faces, or very nearly so to have proper joints for the specified distance from the face. If not carefully superintended, masons will chip off the edges of stone with a hammer leaving full joint for perhaps half an inch from the face.

5.1.8.2 Chisel drafted margin - The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cm. Chisel drafted mrgin shall be punch dressed.

5.1.8.3 Hammer dressed surface - A hammer dressed stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer dressed stone is also known as hammer faced, quarry faced and rustic faced. 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 (Fig.1).

5.1.8.4 Rock faced surface - 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 (Fig.2).

5.1.8.5 Rouch tooled surface - A rouch 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 45^0 as directed (Fig.3). 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).

5.1.8.6 Punched dressed surface - A rouch 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 (Fig.4). Punched dressed stones are used where even surfaces are required.

5.1.8.7 Close picked surface - 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 (Fig.5).

5.1.8.8 Fine tooled surface - 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 centimetre width depending on the degree of hardness of stone and degree of fineness required (Fig.1 to 6). This type of dressing is commonly adopted for ashlar work.

5.1.8.9 Polished surface - Surfaces having a high gloss finish. 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.

5.1.12 SPECIFICATION FOR RANDOM RUBBLE STONE MASONRY:

5.1.12.1 Stone: The stone will be of the type specified such as granite, trap, lime stone, sand stone, quart-zite, etc. and shall be obtained from the quarries, approved by the engineer. Stone shall be hard, sound, durable, and free from weathering decay and defects like cavities, cracks, flaws, sandholes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stone shall be of uniform colour, quality, or texture. Generally stones shall not contain crystalline silica or chart, Mica and other delaterious materials like iron oxide, organic impurities etc. Stones with round surface shall not be used.

The compressive strength of common types of stones shall be as per Table 1 and the percentage of water absorption shall generally not exceed 5% for stones other than specified in Table 1. For laterite this percentage is 12%.

Table 1

Type of stone	Maximum Water Absorption percentage by weight	Minimum Compressive strength kg/sq cm
Granite	0.5	1000
Basalt	0.5	400
Lime stone (Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800

Laterite (Block)	12	35

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.

5.1.12.2 Size of stones - Normally stones used should be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not exceed three times the height and the breadth or base shall not be greater than three-fourth the thickness of the wall, or not less than 15 cm. The height of stone may be up to 30 cm.

5.1.12.3 Random Rubble Masonry shall be uncoursed or brought to courses as specified.Uncoursed random rubble masonry shall be constructed with stones of sizes as referred and shapes picked at random from the stones brought from the approved quarry. Stones having sharp corners or round surfaces shall, however, not be used.

5.1.12.4 Random rubble masonry brought to the course is similar to uncoursed random rubble masonry except that the courses are roughly levelled at intervals varying from 30 cm to 90 cm in height according to the size of stones used.

5.1.12.5 Dressing - Each stone shall be hammer dressed on the face, the sides and bed. 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 and 10 mm on the face to be plastered.
Note:
Dressing is classified ordinarily as:- Single line, two line, or three line according to the degree of fineness to which they have to be dressed.

In single line dressing the maximum projection or depression with reference to the mean plane should not be more than 3 mm, and 1.5 mm in double line and 1 mm in three line dressing. Dressing of stones finer than three lines dressing is known as palmane, which is adopted in special cases, and specially where the surfaces are not to the plane desired even after fine dressing.

5.1.12.6 Mortar - The mortar used for joining shall be as specified.

5.1.12.7 Laying - All stones shall be wetted before use. Each stone shall be placed close to the stones already laid so that the thickness of the mortar joints at the face is not more than 20 mm. Face stones shall be arranged suitably to stagger the vertical joints and long vertical joints shall be avoided. Stones for hearing or interior filling shall be hammered down with wooden mallet into the position firmly bedded in mortar. Chips or sprawls of stones may be used for filing of interstices between the adjacent stones in heartening and

these shall not exceed 20% of the quantity of stone masonry. To form a bond between successive courses plum stones projecting vertically by about 15 to 20 cm shall be firmly embedded in the heartening at the interval of about one metre in every course. No hollow space shall be left any where in the masonry.

The masonry work in wall shall be carried out true to plumb or to specified batter.

Random rubble masonry shall be brought to the level course at plinth, windowsills, lintel and roof levels. Leveling shall be done 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.

The masonry in structure shall be carried out uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45 degree.

5.1.12.8 Bond stones - Bond or through stones running right through the thickness of walls, shall be provided in walls up to 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 the face of the wall to the back.

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 thickness 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 precast cement concrete block of 1:3:6 mix (1cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size) of cross section not less than 225 square centimetres and length equal to the thickness of wall shall be used in lieu of bond stones. (This shall be applicable only in masonry below ground level and where masonry above ground level is finally required to be plastered).
At least one bond stone or a set of bond stones shall be provided for every 0.5 sq m of the area of wall surface. All bond stones shall be marked suitably with paint as directed by the engineer.

5.1.12.9 Quoin and jamb stones - The quoin and jamb stones shall be of selected stones neatly dressed and 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.

5.1.12.10 Joints - Stone 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.

5.1.12.11 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 metre 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).

5.1.12.12 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.

5.1.12.13 Protection - Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

5.1.12.14 Measurements

5.1.12.14.1 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 metre nearest to two places of decimal.

5.1.12.14.2 The work under the following categories shall be measured separately.

1) From foundation to plinth level (level one) :

a) work in or under water and /or liquid mud,

b) work in or under foul positions.

2) From plinth level (Level one) to floor two level.

3) From floor two level to floor three level and so on.

4) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

Note – 1. Floor I is the lowest floor above ground level in the building unless otherwise specified in a particular case. The floors above floor 1 shall be numbered in sequence as floor 2, floor 3 and so on. Number will increase upwards.

2. For floor 1, top level of finished floor shall be the floor level and for all other floors above floor 1, top level of structural slab shall be the floor level.

3. Floor level or 1 or 1.2 m above the ground level whichever is less shall be the plinth level.

5.1.12.14.3 No deduction shall be made nor extra payment made 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 up to 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 plates, and bearing or 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 recess for cement concrete blocks to embed hold fasts for doors, windows, etc.

(v) Building in masonry, iron fixture, pipes up to 300 mm dia, hold fasts of doors and windows etc.

(vi) Forming chases in masonry each up to section of 350 sq cm.

Masonry (excluding fixing brick work) in chimney breasts with smoke of air flues not exceeding 20 sq dm (0.20 sq m) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq dm (0.20 sq m) sectional area, deduction shall be made for the same and pargetting and coring flues shall be measured in running metres 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.

5.1.12.14.4 Apertures for fireplaces shall not be deducted and extra labour shall not be measured for splaying of jambs, throating and making arch to support the opening.

5.1.12.14.5 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.

5.1.13 SPECIFICATIONS FOR COURSED RUBBLE MASONRY FIRST SORT

5.1.13.1 Stone : Shall be as specified in 5.1.12.1

5.1.13.2 Size of Stone : Shall be as specified in 5.1.12.2

5.1.13.3 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 8 cm back from the face, and side joints for at least 4 cm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The bushing on the face shall not project more than 4 cm as an exposed face and one cm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for minimum width of 2.5 cm along the four edges of the face of the stone, when stone work is exposed.

5.1.13.4 Mortar - The mortar for jointing shall be as specified.

5.1.13.5 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 hearting 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 hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting 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 degree. Toothing shall not be allowed.

5.1.13.6 Bond stones - Shall be as specified except that a bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course.

5.1.13.7 Quoins - The quoins shall be of the same height as the course in which these occur. These shall be at least 45 cm long and shall be laid stretches and headers alternatively. These shall be laid square on the beds, which shall be rough-chisel dressed

to a depth of at least 10 cm. In case of exposed work, these stones shall have a minimum of 2.5 cm wide chisel drafts at four edges, all the edges being in the same plane.

5.1.13.8 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.

5.1.13.9 Curing, scaffolding, measurements and rates - Shall be as specified under 5.1.12

5.1.14 SPECIFICATIONS FOR COURSED RUBBLE MASONRY – SECOND SORT :-

5.1.14.1 Stone - Shall be as specified in 5.1.12.1

5.1.14.2 Size of stone - Shall be as specified in 5.1.12.2

5.1.14.3 Dressing - Shall be as specified in 5.1.13.3 except that no portion of dressed surface shall exceed 10 mm from a straight edge placed on it.

5.1.14.4 Mortar - The mortar for jointing shall be as specified.

5.1.14.5 Laying - Shall be as specified in 5.1.13.5 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.

5.1.14.6 Bond stone, quoins - Shall be as specified in 5.1.13.6 and 5.1.13.7

5.1.14.7 Joints - All bed joints shall be horizontal and all side vertical. All joints shall be fully packed with mortar, face joints shall not be more than 2 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, the joints shall be raked to a minimum depth of 20 mm by raking tool during progress of work, where the mortar is still green.

5.1.14.8 Curing, scaffolding, measurement and rates - Shall be as specified in 5.1.12

5.1.15 SPECIFICATIONS FOR PLAIN ASHLAR MASONRY

5.1.15.1 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.

5.1.15.2 Size of stone - Normally stones used should be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three – fourth of the thickness of wall not less than 15 cm. The height of stone may up to 30 cm.

5.1.15.3 Dressing - Every stone shall be cut to the required size and shape, 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. It shall be kept at the worksite as a sample after being approved.

5.1.15.4 Mortar - The mortar for jointing shall be as specified.

5.1.15.5 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 alternatively 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 15 cm in height and all the courses shall be of same height, unless otherwise specified.

For ashlar facing with backing of brick work or coursed rubble masonry face stone shall be laid in alternate courses of headers and stretches 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 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.

5.1.15.6 Bond stones - Shall be as specified in 5.1.12.8.

5.1.15.7 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.

5.1.15.8 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.

5.1.15.9 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.

5.1.15.10 Protections - Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

5.1.15.11 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.

5.1.15.12 Measurements - The finished work shall be measured correct to a centimetre in respect of length, breadth and height. The cubical contents shall be calculated in cubic metre nearest to two places of decimal.

5.1.15.12.1 No deduction nor any extra payment shall be made for the following :
1) Ends of dissimilar materials (that is joists, beams, linthels, posts, girders, rafters, purlins, trusses, corbels, steps etc.) up to 0.1 sqm in section.

2) Openings up to 0.1 sqm in area. In calculating the area of opening, any separate lintels or sills shall be included along with the size of the opening but the end portion of the linthels shall be excluded and extra width of rebated reveals, if any, shall also be excluded.

3) Wall plates and bed plates and bearing of chajja 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 slabs shall be deducted from wall masonry.
1) Drainage holes and recesses left for cement concrete blocks to embed hold-fasts for doors and windows, building in the masonry iron fixture and pipes up to 300 mm diameter.

2) Stone walls in chimney breasts, chimney stacks, smoke or air flues not exceeding 0.20 sqm in sectional area shall be measured as solid and no extra measurement shall be made for pargetting and coring such flues. Where flues exceed 0.20 sqm in sectional area, deduction shall be made for the same and pargetting and coring flues paid for separately.

5.1.15.12.2 Square, rectangular or circular pillars - Shall be measured and paid for as walls, but extra payment shall be allowed for such pillars and columns over the rate for stone work in walls.
Rectangular pillars shall mean a detached masonry support, rectangular in section, such that its breadth shall not exceed two and half times the thickness.

5.1.15.12.3 Curved stone work - Stone work curved on a plan to a mean radius exceeding six metres shall be measured net and included with general stone work. Stone work circular on a plan to a mean radius not exceeding six metres 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.

5.1.15.13 Rate - The rate shall include the cost of materials and labour required for all the operations described above. Stone facing or wall lining up to 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.

5.1.16 SPECIFICATIONS FOR PUNCHED ASHLAR (ORDINARY) MASONRY

5.1.16.1 **Stone -** Shall be as specified in 5.1.15.1

5.1.16.2 **Size of stone -** Shall be as specified in 5.1.15.2

5.1.16.3 Dressing - Shall be as specified in 5.1.15.3 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 more than 3 mm from a straight edge placed over it.

5.1.16.4 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 5.1.15.

5.4 SPECIFICATIONS FOR HOLLOW AND SOLID CONCRETE BLOCK MASONRY

5.4.1 Hollow and solid concrete blocks – Shall conform to the requirements of IS:2185. Specification for hollow and solid concrete blocks except with regard to the mix of cement concrete and sizes of aggregates which shall be as indicated. Hollow blocks shall be sound, free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of block or impair the strength or performance of construction.

5.4.2 Dimensions and tolerances :

5.4.2.1 Concrete masonry building units shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block, and concrete floor units.

5.4.2.2 Concrete block-hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions.

The nominal dimensions of concrete block shall be, as follows :

Length	:	400, 500 or 600 mm
Height	:	200 or 100 mm
Width	:	50,75, 100, 150, 200, 250 or 300 mm.

In addition, block shall be manufactured in half lengths of 200, 250 and 300 mm to correspond to the full lengths.

The maximum variation in the length of the units shall be not more than +/- 5 mm and maximum variation in height and width of unit, not more than +/- 3mm.

5.4.3 Classification :

5.4.3.1 Hollow (open and closed cavity) concrete blocks.

The hollow (open and closed cavity) concrete blocks shall conform to the following three grades :

a) **Grade 'A' -** These are used as load bearing units and shall have a minimum block-density of 1500 kg/m3. These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5 and 7.0 N/mm2 respectively at 28 days (See Table 5).

b) **Grade 'B' -** These are also used as load bearing units and shall have a block density less than 1500 kg/m3 but not less than 1000 kg/m3. These shall be manufactured for minimum average compressive strengths of 2.0, 3.0 and 5.0 N/mm2 respectively at 28 days. (See Table 5).

c) **Grade 'C' –** These are used as non-load bearing units and shall have a block density less than 1500 kg/m3 but not less than 1000 kg/m3. These shall be manufactured for minimum average compressive strength of 1.5 N/mm2 at 28 days (see Table 5).

d) **Grade 'D' –** The solid concrete blocks are used as load bearing units and shall have a block density not less than 1800 kg/m3. These shall be manufactured for minimum average compressive strengths of 4.0 and 5.0 N/mm2 respectively (see Table 5).

5.4.4 Physical requirements :

5.4.4.1 Compressive strength – The average crushing strength of eight blocks, when determined in accordance with IS : 2185 shall not less than as specified in table 3:

Table 5
Physical requirements

Type	Grade	Densiy of block Kg/mm^3	Minimum Average compressive strength of units	Minimum strenght of individual units N/mm^2
Hollow (open & closed cavity) load bearing unit	A (3.5)	Not less than 1500	3.5	2.8
	A(4.5)		4.5	3.6
	A(5.5)	Not less than 1500 but not less than 1000	5.5	4.4
	A(7.0)		7.0	5.6
	B(2.0)		2.0	1.6
	B(3.0)		3.0	2.4
	B(5.0)		5.0	4.0
Hollow (open and closed cavity) non-load bearing units	C(1.5)	Less than 1500 but not less than 1000	1.5	1.2
Solid load	D(5.0)	Not less than 1800	5.0	4.0
Bearing Units	D(4.0)		4.0	3.2

5.4.4.2 Drying shrinkage – The drying shrinkage of the blocks (average of three blocks), when unrestrained, shall be determined in accordance with IS:2185 and shall not be exceed 0.1 per cent.

5.4.4.3 Moisture movement – The moisture movement (average of three blocks), when determined as described in IS:2185 shall not exceed 0.09 percent.

5.4.4.4 Water absorption – The water absorption (average of three blocks), when determined in the manner described in IS:2185 shall be not more than 10 per cent by mass.

5.4.4.5 Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the core moulds used, the face shells and webs shall be flared and tapered or straight tapered, the former providing a wider surface for mortar. The thickness of the face shell and web shell be not less than the values given in Table 4.

Table 6
Minimum face shell and web thickness

Nominal block length width	Face shell Thickness	Thickness of Web	Total web thickness per course in any 200 mm of walling
	Min.	Min.	Min.
(1)	(2)	(3)	(4)
100 or less	25	25	25
Over 100 to 150	25	25	30
Over 150 to 200	30	25	30
Over 200	35	30	38

5.4.4.6 Subject to the tolerance as specified in 5.4.2.2 and 5.4.4.7, the face of masonry units shall be flat and rectangular, opposite face shall be parallel, and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

5.4.4.7 Blocks with special faces shall be manufactured and supplied as directed by the engineer.

5.4.5 Curing and drying - The blocks shall be cured in an immersion tank or in a curing yard and shall be kept continuously moist for at least 14 days. When the blocks are cured in an immersion tank, the water of tank shall be changed at least every four days.

After curing, the blocks shall be dried in shade before being used on the work. They shall be stacked with voids horizontal to facilitate through passage of air. The blocks shall be allowed to complete their initial shrinkage before they are laid in wall.

5.4.6 Construction of masonry - For single storeyed buildings, the hollows of blocks in foundation and basement masonry shall be filled up with sand and only the top foundation course shall be of solid blocks. But for two or more storeyed buildings, solid concrete blocks shall be used in foundation courses, plinth, and basement walls, unless otherwise indicated. If hollow blocks are used, their hollows shall be filled up with cement concrete 1:3:6 using 12.5 mm nominal size aggregates.

5.4.7 Wetting of blocks - Blocks need not be wetted before or during laying in the walls. In case the climate conditions so require, the top and the sides of the blocks may only be slightly moistened so as to prevent absorption of water from the mortar and ensure the development of the required bond with the mortar.

5.4.8 Laying - Blocks shall be laid in mortar, as indicated and thoroughly bedded in mortar, spread over the entire top surface of the previous course of blocks to a uniform layer of not less than 10 mm and not more than 12 mm in thickness.

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Blocks shall break joints with those above and below for not less than quarter of their length. Precast half length closers (and not cut from full size blocks) shall be used. For battered faces, bedding shall be at right angles to the face unless otherwise directed. Care shall be taken during construction to see that edges of blocks are not damaged.

5.4.9 Provisions for door and window frames - A course of solid concrete block masonry shall be provided under door and window openings (or a 10 cm thick precast concrete sill block under windows). The solid course shall extend for at least 20 cm beyond the opening on either side. For jambs of very large doors and windows either solid units are used, or the hollows shall be filled in with concrete of mix 1:3:6 using 12.5 mm nominal size aggregates.

5.4.10 Provisions for roof - The course immediately below the roof slab shall be built with solid blocks. The top of the roof course shall be built with solid blocks. The top of the roof course shall be finished smooth with a layer of cement and coarse sand mortar 1:3, 10 mm thick and covered with a thick coat of white wash or crude oil, to ensure free movement of slab.

5.4.11 Intersecting walls - When two wall meet or intersect and the course are to be laid up at the same time, a true masonry bond between at least 50% of the units at the intersection is necessary. When such intersecting walls are laid up separately, pockets with 20 mm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets.

5.4.12 Piers - The top course of block in the pier shall be built in solid blocks. Hollow concrete block shall not be used for isolated piers, unless their hollows are specified to be filled with cement concrete.

5.4.13 Fixtures, fittings, etc. shall be built into the masonry in cement and coarse sand mortar 1:3 while laying the blocks where possible. Hold fasts shall be built into the joints of the masonry during laying.

Holes, chases, sleeves, openings, etc. of the required size and shape shall be formed in the masonry with special blocks while laying, for fixing pipes, service lines, passage of water etc. After service lines, pipes etc. are fixed, voids left, if any, shall be filled up with cement concrete 1:3:6 (1 cement : 3 coarse sand: 6 stone aggregate 20 mm nominal size) and neatly finished.

5.4.14 Finishes - Rendering shall not be done to the walls when walls are wet. Joints for plastering or pointing as specified shall be raked to a depth of 12 mm. Joints on internal faces, unless otherwise indicated, shall be raked for plastering. If the internal faces of masonry are not be plastered the joints shall be finished flush as the work proceeds or pointed flush where so indicated.

SECTION 6
BRICKWORK

6. SPECIFICATIONS FOR BRICKS/RICK TILES/ BRICK BATS

6.1.Bricks/Brick tiles/Brick bats - Bricks used in the masonry may be of the following type:

a) Common burnt clay bricks - Shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warpage and organic matter have a frog 100mm to 20 mm deep on one of its flat sides. Bricks made by extrusion process and brick tiles may not be marked with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

b) Fly ash lime brick - Shall be sound, compact and uniform in shape free from visible cracks, warpages flaws and organic matter, have a frog 100 mm in length. 40mm width and 10 to 20 mm deep on one of its flat side. The shape and size of the frog shall conform to IS: 12894.

Fly Ash : Flay ash shall conform to grade I or Grade 2 of IS: 3812.

Bottom ash used as replacement of sand shall not have more than 12% loss on ignition when tested.

Sand : Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime : Lime shall conform to Class ' C ' hydrated lime of IS: 712.

Additives : Any Suitable additive considered not detrimental to the durability of bricks may be used.

c) Clay fly ash bricks - The clay fly ash brick shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter. The bricks shall be 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.

d) Fly ash shall conform to grade I of II of IS: 3812

Calcium silicate bricks - Calcium silicate bricks shall be sound, compact and uniform in shape – bricks shall be free from visible cracks, warpage organic matter, large pebbles and nodules of free lime. Bricks shall be solid and with or without frog. The bricks shall be made of finely grounded sand siliceous rock and lime. In addition, limited quantity of fly ash conforming to IS: 3812 may be used in the mix.

e) Tile brick - The bricks of 4 cm height shall be moulded without frogs. Where modular tiles are not freely available in the market, the tile bricks of F.P.S. thickness 44mm (1-3/4") shall be used unless otherwise specified.

f) Brick bats - Brick bats shall be obtained from well burnt bricks.

6.1.1. **Dimensions -** The brick may be modular or non-modular. Size for both types of bricks/ tiles shall be as per Table 1. While use of modular brick tiles is recommended, non-modular (FPS) bricks/tiles can also be used where so specified. Non –modular bricks/tiles of sizes other than the sizes mentioned in table 1 may also be used where specified.

Table 1

Type of Bricks/tiles	Nominal size mm	Actual size mm
Modular Bricks	200x100x100mm	190x90x90mm
Modular Tile Bricks	200x100x40mm	190x90x40mm
Non-Modular Tile Bricks	229x114x44mm	225x111x44mm
Non-Modular Bricks	229x114x70mm	225x111x70mm 225x112.5x65mm

6.1.2. Classification - Bricks/Brick tiles shall be classified on the basis of their minimum compressive strength as given below.

Table 2

Class Designation	Average compressive strength			
	Not less than		Less than	
	N/mm²	(kgf/cm²)	N/mm²	(kgf/cm²)
10(100)	10	(100)	12.5	125
7.5(75)	7.5	(75)	10	100
5(50)	5	(50)	7.5	75
3.5(35)	3.5	(35)	5.0	50

The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck.

(Note: Upper limits specified in Table 2 are for calculating the average compressive strength in accordance with Annexure 6-A.2.)

6.1.3. Sampling and tests - Sampling of bricks shall be subjected to the following tests

(a) Dimensional tolerance
(b) Water absorption
(c) Efflorescence
(d) Compressive strength

6.1.3.1. Sampling - 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 3 below. The sample thus taken shall be stored in a dry place until tests are made. For the purpose of sampling the following definition shall apply.

a) Lot - A collection of same class and size, manufactured under relatively similar conditions of production. For the purpose of sampling a lot shall contain a maximum of 50,000 bricks

In case a consignment has bricks more than 50,000 of the same classification and size and manufactured under relatively similar conditions of production , it shall be divided into lots of 50,000 bricks or part there of.

b) Sample - A collection of bricks selected for inspection and/ or testing from a lot to reach the decision regarding the acceptance or rejection of the lot.

c) Defective - A brick failing to meet one or more of the specified requirements.

6.1.3.2 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 real or imaginary 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 to enable units to be sampled from places within the stack.

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 criteria for conformity for visual and dimensional characteristics: -

Visual characteristics - The bricks shall be selected and inspected for ascertaining their conformity to the requirements of the relevant specification.

The number of bricks to be selected from a lot shall depend on the size of lot and shall in accordance of col. 1 and 2 of table 3 for visual characteristics in all case and dimensional characteristics if specified for individual bricks.

(ii) Visual characteristics - All the bricks selected above in accordance with col. 1 and 2 of table 3 shall be examined for visual characteristics. If the number of defective bricks found in the sample is less than or equal to the corresponding number as specified in col.3 of table 3 the lot shall be considered as satisfying the requirements of visual characteristics, otherwise the lot shall be deemed as not having met the visual requirements.

(iii) 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 3. These bricks will be divided into groups of 20 bricks at random and each 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 tolerance, if none of the groups of bricks inspected fails to meet the specified requirements.

Table 3

Scale of sampling and permissible number of defectives for visual and dimensional characteristics

No. of bricks in the lot	For characteristics specified for individual bricks		For dimensional characteristics for group of 20 bricks- No. of bricks to be selected
	No. of bricks to be selected	Permissible no of defective in the sample	
2001-10000	20	1	40
10001-35000	32	2	60
35001-50000	50	3	80

Note: In case the lot contains 2000 or less bricks the sampling shall be as per decision of the engineer.

iv) 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 4.

Table 4

Lot Size	Sample size for compressive strength, water absorption and efflorescence	Permissible No. of defectives for efflorescence
2001-10000	5	0
10001-35000	10	0
35001-50000	15	1

Note - In case the lot contains 2000 or less bricks, the sampling shall be as per decision of engineer.

v) A lot shall be considered having satisfied the requirements of physical characteristics if the condition stipulated here in are all satisfied.

(a) From the test results for compressive strength the average shall be calculated and shall satisfy the requirements specified in relevant material specification.

Note - 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 average

(b) Where 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 per cent.

(c) From the test results for water absorption, the average for the bricks in the sample shall be calculated and shall satisfy the relevant requirements shall satisfy the relevant requirements specification in material specification.

(d) The number of bricks failing to satisfy the requirements of the efflorescence specified in the relevant specification should not be more than the permissible no. of defectives given in col. 3 of table 4.

6.1.3.3. Dimensional tolerances - The dimensions of modular bricks when tested as described above as per procedure described in Annexure 6-A.1 shall be within the following limits per 20 bricks.

Length 372 to 388 cm (380 ± 8 cm)

Width 176 to 184 cm (180 ± 4 cm)

Height 176 to 184 cm (180 ± 4 cm) for 90 cm

high bricks

6.2. SPECIFICATIONS FOR BRICK WORK

6.2.1. Classification - The brick work shall be classified according to the class designation of bricks used.

6.2.2. 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 brickwork.

6.2.3. Soaking of bricks - Bricks 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. The bricks required for masonry work using mud mortar shall not be soaked. 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 where they are not again spoiled by dirt earth etc.

Note 1 - The period of soaking be easily found at site by a field test in which the bricks are soaked in water for extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note 2 - If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

6.2.4. Laying

6.2.4.1. Bricks shall be laid in english bond (fig.2.3.4.) unless otherwise specified. For brick work 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 plan for ensuring better alignment.

Note - 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.

6.2.4.2. All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar when laying each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its 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 such that no hollow spaces are left inside the joints.

6.2.4.3. 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 propounds properly aligned within following maximum permissible tolerances:

a) Deviation from vertical within a storey shall not exceed 6 mm per 3m height.

b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5. mm

c) Deviation from position shown on plan of any brickwork shall not exceed 12.5. mm

d) Relative displacement between load bearing wall in adjacent storey intended to be vertical alignments all not exceed 6 mm.

e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 meter rule line and plumb shall be kept on the site of work for every 3 masons for every 3 masons for proper check during the progress of work.

6.2.4.4. All quoins shall be accurately contracted and 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. The position of damp proof course, windowsills, bottom of lintels top of the wall etc, along the height of the wall shall be marked on the graduated straight edge or storey rod. 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.

6.2.4.5. The brickwork shall be built in uniform layers. **No part of the wall during its construction shall rise more than one meter above the general contraction level**. Parts of wall left at different levels shall be raked back at an angle of 45 degrees 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.

6.2.4.6. 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.

6.2.4.7. Top courses of all plinths, parapets, steps and 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 corners as shown in Fig. 4. Where bricks cannot be cut to the required shape to from cut corners, cement concrete

1:2:4(1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.

6.2.4.8. 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.

6.2.4.9. In case of walls one brick thick and under one face shall be kept even and in proper plane, which 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.

6.2.4.10. 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.

6.2.4.11. 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.

6.2.4.12. Care shall be taken during construction that edges of jambs sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage if any, shall be made good to the satisfaction of the engineer.

6.2.4.13. Vertical reinforcement in the form of bars (MS or high strength deformed bars) 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 (1 Cement 4 coarse sand) or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The Dai of bars shall not be less than 8 mm and concrete grade shall be minimum 1:3:6 (1 cement 3 coarse sand: 6 graded stone aggregate 20 mm nominal size).

6.2.4.14. In retaining walls and the like where water is likely to accumulate weep holes, 50 to 75 mm square 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 helps shall be surrounded by loose stones and shall have sufficient fall to drain of the water quickly.

(Note - Work of providing loose stone will be payable extra).

6.2.4.15. Work of cutting chases, where 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 guidelines given below:

(a) Cutting of chases in one brick thick and above load bearing walls

(i) As far as possible services should be planned with the help the 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 length of walls) such as between doors and windows, cannot be avoided they should not be pierced with openings for soil or waste pipes or 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 one third or 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 is masonry may be provided upto to cm width and 30 cm height without any lintel. In the case of circular holes in the masonry, no linthel need be provided for holes upto 40 cm in diameter.

(b) 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 thick load bearing walls.

(c) 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.

6.2.5. Joints - The thickness of all types of joints including brick wall joints and shall 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 one – fifth of specified thickness.

6.2.5.1. Finishing of joints - The face of brickwork be finished flush or by pointing. In flush finishing either the face joints of mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is till green for subsequently plastering. The faces of brickwork shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brickwork. 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.,

6.2.6.Curing - The brickwork shall be constantly kept moist on all faces for a minimum period of seven days. Brickwork done during the day shall be suitably marked indicating the date on which the work is done so as of keep a watch on the curing period.

6.2.7. Scaffolding - Scaffolding shall be strong to withstand all dead, live and impact loads, which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

6.2.7.1. Single scaffolding - Where plastering pointing or any finishing has been indicated for brickwork single scaffolding may be provided unless otherwise specified. In single scaffolding 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 rest in the hole provided in the header coarse 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 metre in length between the openings or near the skewbacks of arches or immediately under or near the structural member supported by the walls. The holes for putlogs / poles shall be made good with brickwork and wall finishing as specified.

6.2.7.2. Double Scaffolding - 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.

on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

6.2.8.3 No deductions or additions shall be done and no extra payment made for the following:

Note - Where minimum area is defined for **6.2.8. Measurements**

6.2.8.1. Brickwork 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. 1 cm. Areas shall be calculated to the nearest 0.01 sq.mtrs and the cubic contents shall be worked out to the nearest 0.01 cubic meters.

6.2.8.2 Brickwork shall be measured separately in the following stages

(a) From foundation to floor one level (Plinth level)

(b) Plinth (floor one) level to floor two level

(c) Between two specified floor levels above floor two level

Note - (1) Brick work in parapet walls, mumty, lift machine room and water tanks constructed deduction of an opening or void or both such areas shall refer only to opening or void the space measured.

a) Ends of dissimilar materials (that is, joints beams, lintels, posts, girders, rafters, purlins trusses, corbels, steps etc.,) up to 0.1 m^2 in section.

b) Opening up to 0.1.m^2 in area (see Note)

c) Wall plates, bed plates and bearing of slabs chejjas 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 holdfasts 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 drip course bearing of moulding and cornice.

Note - 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.

6.2.8.4. Walls half brick and less shall each be measured separately in square meters stating thickness.

6.2.8.5. 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 6.1.1. 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 ¼ brick- full half bricks.

6.2.8.6. String courses, projecting pilasters, aprons sills and other projections shall be fully described and measure separately in running meters stating dimensions of each projection.

6.2.8.7. Square or rectangular pillars shall be measured separately in cubic meters in multiple of half brick.

6.2.8.8. Circular pillars shall be measured separately in cubic meters as per actual dimensions.

6.2.8.9. Brick work curved on plan shall be measured like the brick 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 brickwork curved in plan exceeds six meters.

6.2.8.10. Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for brickwork in walls.

6.2.8.11. Brick work with brick tiles shall be measured and paid for separately.

6.2.9. Rate - The rate shall include the cost of materials and labour 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:

a) Raking out joints or finishing joints flush as the work proceeds;

b) Preparing tops of existing walls and the like for raising further new brick work.

c) Rough cutting and waste for forming gables splays at eaves and the like.

d) Leaving holes for pipes upto 150 mm dia and encasing hold fasts etc.,

e) Rough cutting and waste for brick work curved in plan and for backing to stone or other types of facing.

f) Embedding in ends of beams , joints slabs, lintels , sills, trusses etc.,

g) Bedding wall plates lintels, sills, roof tiles corrugated sheets etc in or on walls if not covered in respective items and

h) Leaving chases of section not exceeding 50 cm in girth or 350 sq in cross – section.

I) Brick on edge courses, cut brick corners, splays reveal, cavity walls, brick works, curved on plan to a mean radius exceeding six meters.

6.3. SPECIFICATIONS FOR BRICK WORK IN ARCHES

6.3.0. The detailed specifications for brick work mentioned in 6.2 shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. 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 give proper radials to the end voussiors. Defects in dressing of bricks shall not be permitted by extravagant use of mortar, nor shall the use of chips or bats etc., be permitted.

The bricks of the spandrel wall at their junction with the extrudes of the arch shall be cut fit the curvature of the arch.

6.3.1. Circular arches - These shall be either (a) plain arches, and shall be built in half brick concentric rings with break joints, or (b) gauged arches built with bricks cut or moulded to proper shape. The arch work shall be carried up from both ends extraneously and keyed in the centre. The bricks shall be flush with mortar and well pressed into their positions so 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 be full of mortar and thickness of joints shall not be less than 5 mm nor more than 15 mm.

After the arch is completed, the haunches shall be loaded by filling up the spandrels upto 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 voussiors shall break joints to the full depth of the arch.

6.3.2. Flat arches - These shall be gauged arches of brick cut or moulded to proper shape. The extrudes shall be kept horizontal and the intrudes shall be given slight camber of 1 in 100 of the span. The center 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 voussiors breaking joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the center. 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.

6.3.3. Centering and shuttering - The centering and shuttering for the arch shall be got approved by the engineer before the arch work is started. 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 sandboxes, 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. The shuttering shall be struck within 48 hours. This shall be done after the spandrel has been filled in and the arch loaded.

6.3.4. Measurements - The length of the arch shall be measured as the mean of the extrudes and intrudes 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.

6.3.5. Rate - The rate is inclusive of the cost of the materials and labour for all the operations described above.

6.4. Half brickwork - Brick work in half brick walls shall be done in the same manner as described above in 6.2.4 except that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced. 2Nos. M.S. bars of 6mm 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 brickwork to which the half brickwork is joined. The mortar used for reinforced brickwork shall be rich dense cement mortar of mix 1:4. Lime mortar shall not be used. 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 5mm. The mortar covering in the direction of joints shall not be less than 15 mm.

6.4.1. Measurements - The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m 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.

6.4.2. 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.

6.5. SPECIFICATIONS FOR BRICK TILE WORK

6.5.0. The work shall be done in the same manner as described in 6.2.4. except that brick tile shall be used instead of bricks. The measurements and rate shall be same as specified under 6.2.

6.6. SPECIFICATIONS FOR HONEYCOMB BRICKWORK - The brick honeycomb work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to given an even surface.

The thickness of the brick honeycomb works shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2cm on either side.

6.6.1 Measurements - The length and height shall be measure correct to a cm. Area shall be calculated in square meters correct to two places of decimal. Honeycomb openings shall not be deducted.

6.6.2. Rate - The rate includes the cost of materials and labour involved in all the operations described above.

SECTION 14
FLOORING WORK

14.2 SPECIFICATIONS FOR CEMENT CONCRETE FLOORING

14.2.1 Cement concrete - Cement concrete of specified mix shall be used and it shall generally conform to the specifications described in section 3.

14.2.2 Base concrete

14.2.2.1. Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah courtyard kitchens & baths shall have slope ranging from 1 48 to 1 60 depending upon location and as decided by the engineer. Floors in water closet portion shall have slope of 130 or as decided by the engineer to drain off washing water. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it.

14.2.2.2. If the base consists of lime concrete, it shall be allowed to set for seven days and the flooring shall be laid within the next three days.

14.2.2.3. If the base is of lean cement concrete, the flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry at 2 kg of cement

spread over an area of one sqm so as to get a good bond between the base and concrete floor.

14.2.2.4. If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

14.2.3 Thickness - The thickness of floor shall be as specified in the description of the item.

14.2.4 Laying

14.2.4.1 Panels - Flooring of specified thickness shall be laid in the pattern including the border/ or as given in the drawings or as directed by the engineer. The border panels shall not exceed 450 mm in width and the joints in the border in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm.

14.2.4.2 Laying of flooring with strips - Normally cement concrete flooring shall be laid in one operation using glass / plain asbestos/ aluminium/PVC / brass strips or any other strips as required as per drawing or instructions of the engineer, at the junction of two panels. This method ensures uniformly in colour of all the panels and straightness at the junctions of the panels. 4 mm thick glass strips or 5 mm thick plain asbestos sheet, 2 mm PVC strips or 2 mm aluminium or brass strips, shall be fixed with their tops at proper level, giving required slopes. Cost of providing and fixing strips shall be paid for separately.

Concreting - Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge and made true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

14.2.4.3 Laying of flooring without strips

14.2.4.3.1 Laying of cement concrete flooring in alternate panels may be allowed by the engineer in case strips are not to be provided.

14.2.4.3.2 Shuttering - The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These 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 (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

14.2.4.3.3 Concreting - The concreting shall be done in the manner as described. The angle iron / flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged 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.

14.2.5 Finishing

14.2.5.1 The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

14.2.5.2 Fresh cement shall be mixed with water to form a thick slurry and spread at the rate of 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.

14.2.5.3 The edges of sunk floors shall be finished and rounded with cement mortar 12 (1 cement 2 coarse sand) and finished with a floating coat of neat cement.

14.2.5.4 The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

14.2.5.5 The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

14.2.6 Curing - The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

14.2.7 Precautions - Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good. During cold weather, concreting shall not be done when the temperature falls below 4 degree 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, precautions shall be taken to see that the temperature of wet concrete does not exceed 38 degree C. No concreting shall be laid within half an hour of the closing time of the day, unless

permitted by the engineer. To facilitate rounding of junction of skirting, dado and floor, the skirting / dado shall be laid along with the border or adjacent panels of floor.

14.2.8. Measurement - 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. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

14.2.9 Rate - 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. Nosing of steps where provided shall be paid for separately in running metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunk floors. In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

14.3 SPECIFICATIONS FOR CEMENT CONCRETE FLOORING WITH TOPPING OF RED OXIDE OF IRON

14.3.1 Cement concrete - Cement concrete of specified mix shall be used and it shall generally conform to the specification described in section 4.

14.3.2 Base concrete - It shall be as specified in 14.2.2

14.3.3 Under layer

14.3.3.1 The under layer of flooring shall be of cement concrete of specified thickness. The mix shall be 124 (1 cement 2 coarse sand 4 graded stone aggregate 12.5 mm nominal size) by volume otherwise described in the item. As regards laying, the work shall be carried out in the manner as specified except that

a) Angle or flat iron used for shuttering shall be to the height of both the under and top layers of the floor.

b) The under layer shall not be left smooth but roughened with 2 mm deep diagonal lines at 7.5 cm centres both ways with a scratching tool to form a key for the finishing coat of red oxide of iron. No cement slurry be added to the concrete surface, and

c) The angle or flat shall be removed only 24 hours after the top layer has been laid. The surface of under layer shall be left even and true to slope.

14.3.4 Top layer

14.3.4.1 This shall consist of uniform and smooth layer of plaster of 10 mm minimum thickness unless otherwise specified and of mix 13 (1 cement 3 coarse sand) unless otherwise specified, finished with a floating coat of neat cement. In both plaster and floating coat the ratio of cement to red oxide of iron specified in the description of item shall be adopted. Normally 3.5 kg. of red oxide of approved quality to 50 kg of cement shall be mixed. This ratio may, however, be adjusted to the tinge ordered by the engineer. The red oxide shall be dry mixed thoroughly with the cement and then sand added and mixed. The full quantity of dry mortar required for a room shall be prepared in one lot In order to ensure uniform colour. Wet mortar shall be prepared in the usual manner as and when required.

14.3.4.2 Laying - The top layer shall be laid, the following day after the under layer has been laid. The plaster shall be done to a uniform thickness of 10 mm and finished smooth with cement slurry (2.0 kg of cement, red oxide mix per square metre of flooring mixed in the ratio used) for the plaster. The surface shall then be brought to a fine polish by use of polishing stones.

The angle or flats used for shuttering of panels shall be removed the next day, after the laying of the top layer and broken edges repaired with the same coloured mortar as in plaster.

The under layers of the alternate panels and the coloured plaster on top shall then be laid as described above. In laying such alternate panels care shall be taken that concrete and coloured mortar droppings do not disfigure the coloured topping previously finished.

The junction of floor with wall plaster, dado or skirting shall be rounded off nearly where so required, up to 25 mm radius. Men engaged on the finishing operations shall be provided with raised wooden platforms to sit on, so as to prevent damage to new work.

14.3.5 Thickness - The thickness of the under layer panels shall be as specified in the description of the item and shall be measured correct to 1 cm. The thickness of the top layer shall not be less than that specified.

14.3.6 Curing - The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty cement gunnies shall be avoided as the colour is likely to be bleached with the remnants of cement matter from the bags.

14.3.7 Precautions - These shall be as specified in 14.2.7.

14.3.8 Measurements - These shall be as specified14.2.8.

14.3.9 Rate - The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on base concrete

including roughening and cleaning the surface of base concrete. The base concrete shall be paid for separately. Strips and nosing of steps where provided shall be paid for separately in running metre.

Where the quantity of red oxide used is different from what is described in the item to get the tinge required by the engineer. The difference in quantity shall be subject to corresponding adjustment in the rate for the item.

14.4 SPECIFICATIONS FOR CEMENT CONCRETE FLOORING WITH METALLIC HARDENER TOPPING

14.4.0. Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic hardener is justified on the basis of cost. Where metallic hardener topping is used, it shall be 12 mm thick.

14.4.1 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 it shall be tested as described in Appendix A.

14.4.2 Base concrete - It shall be as specified 14.2.2

14.4.3 Under layer - Cement concrete flooring of specified thickness and mix shall be laid as under layer (14.3.1 and 14.3.3). The top surface shall be roughened with brushes while the concrete is still green and the forms shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping.

14.4.4 Topping - This shall consist of 12 mm thick layer of mix 12 (1 cement 2 stone aggregate 6 mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 14 (1 metallic concrete hardener 4 cement) by weight. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6 mm nominal size or as otherwise specified in the ratio of 12 (1 cement 2 stone aggregate) by volume, and well turned over. Just enough water shall then be added to this dry as required for floor concrete.

The mixture so obtained shall be laid in 12 mm thickness, on cement concrete floor within 2 or 4 hours of its laying. The topping shall be laid true to provide a uniform and even surface. It 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 junction of floor with wall plaster, dado or skirting and finishing operations shall be dealt with as described in 14.2.4.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on, so as to prevent damage to new work.

14.4.5 Measurements and rates - The specifications for curing, precautions to be taken, 'Measurements' and 'Rates' shall be as specified in 14.2

14.5 SPECIFICATIONS FOR CEMENT PLASTER IN RISERS OF STEPS, SKIRTING, DADO

A band of plaster at the bottom of wall not exceeding 30 cm in height above the floor shall be classified as skirting. It shall be flush with wall plaster or projecting out uniformly by 6 mm from the wall plaster, as specified. The work shall be preferably carried out simultaneously with the laying of floor. It's corners and junctions with floor shall be finished neatly as specified.

14.5.1 Thickness - The thickness of the plaster specified shall be measured exclusive of the thickness of key i.e., grooves or open joints in brick work. The average thickness shall not be less than the specified thickness. The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges. Extra thickness required in rounding of corners at junctions of wall shall be ignored.

14.5.2 Preparation of wall surface - The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surfaces shall be roughened by hacking. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

14.5.3 Application - Skirting with specified mortar and to specified thickness shall be laid immediately after the surface is prepared. It shall be laid along with the border or adjacent panels of floor. The joints in skirting shall be kept true and straight in continuation of the line of joints in borders or adjacent panels. The skirting shall be finished smooth and true, with top truly horizontal and joints truly vertical except where otherwise indicated.

14.5.4 Finishing - The finishing of surface shall be done simultaneously with the borders of the adjacent panels of floor. The cement to be applied in the form of slurry for smooth finishing shall be at the rate of 2 kg of cement per litre of water applied over an area of 1 sqm.

Where skirting is flush with plaster, a groove 10 mm wide and up to 5 mm deep shall be provided in plaster at the junction of skirting with plaster.

14.5.5 Curing - Curing shall be commenced on the next day of plastering when the plaster has hardened sufficiently and shall be continued for a minimum period of 7 days.

14.5.6 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 stating 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.

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

14.6 SPECIFICATIONS FOR CEMENT PLASTER SKIRTING FINISHED WITH RED OXIDE OF IRON

14.6.1 Under coat - The under coat of skirting shall be of cement plaster of the thickness and mix described in the item. Specifications as given shall apply. As regards application, the work shall be carried out in the manner as described except that the under coat shall be finished rough with a scratching tool to form a key for the top coat.

14.6.2 Top coat

14.6.2.1 Mortar - This shall consist of uniform and smooth layer of plaster of specified thickness and of mix 13 (1 cement 3 coarse sand) unless otherwise specified, finished with a floating coat of neat cement. In both plaster and floating coat the ratio specified in the description of item shall be adopted. Normally 3.5 kg of red oxide of approved quality to 50 kg of cement shall be mixed. This ratio may, however, be adjusted to the tinge ordered by the engineer. The red oxide shall be mixed with the cement and then sand added and mixed. The full quantity of dry mortar required for a room shall be prepared in one lot in order to ensure uniform colour. Wet mortar shall be prepared in the usual manner as and when required.

14.6.2.2 Application - The top coat shall be done the next day after the under coat has been applied. The plaster shall be done with the thickness specified and finished smooth, by application of cement – rod oxide mix, at the rate of 1.0 kg. per square metre of surface. The ratio adopted for the mix being the same as that of the plaster. When the surface has hardened sufficiently it shall be brought to a fine polish by use of polishing stones.

14.6.3 Thickness - The thickness of the bottom and top coats shall be as specified. The total thickness of skirting specified is of total thickness of plaster as measured from the un-plastered face of the masonry. Average thickness of the under coat shall not be less than 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 specified.

14.6.4 Curing - Curing shall be commenced on the next day of plastering when the plaster has hardened sufficiently and shall be continued for a minimum period of 7 days.

14.6.5 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 stating 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.

14.6.6 Rate - The rate shall include the cost of all materials and labour involved in all the operations described above.

Where the quantity of red oxide used is different from what is described in the item to get the tinge required by the engineer, the difference in quantity used will be subject to corresponding adjustment in the rate for the item.

14.7 SPECIFICATIONS FOR CEMENT CONCRETE PAVEMENT IN COURTYARD AND TERRACE ETC.

14.7.1 Specifications as described under 14.2.1, 14.2.2.1, 14.2.3, 14.2.4, 14.2.6.6, 14.7 shall hold good as far as applicable except that

i) The panels shall be of uniform 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 up to 50 mm.

ii) Concreting shall be done in alternate panels only and no glass / asbestos strips shall be provided.

14.7.2 Finishing - The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up.

Use of dry cement or cement and sand mix sprinkled on the surface to stiffen the concrete or to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided. 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.

14.7.3 Measurements - Same as 14.2.8 except that the volume will be calculated in cum nearest to two decimal places.

14.7.4 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 for separately. Chequering to pattern shall be paid for separately unless otherwise specified.

14.8 SPECIFICATIONS FOR TERRAZO (MARBLE CHIPS) FLOORING LAID IN SITU

14.8.0 Materials

a) Aggregates used in terrazzo topping shall be marble aggregates with size varying from 1 mm to 25 mm. Marble powder used in terrazzo topping shall pass through IS sieve 300. Aggregate for terrazzo underlayer as well as the base concrete shall confirm to IS 383-1970.

b) Cement – Cement shall confirm to IS 2691989, or IS 4551989, IS 1489(part 1 and 2)-1991, or any other cement as specified.

c) White Cement- It shall confirm to IS 8042-1989.

d) Pigments – The pigments shall be of permanent colour and shall conform to the requirements mentioned in Table 1.

e) Water – Water for use in terrazzo work shall be as specified.

f) Dividing strips – The material for dividing strips shall be such that it has similar resitance to wear as the flooring. The dividing strips may be of aluminium, brassm copper, glass, plastic or similar materials. Aluminium dividing strips should have protective coating of bitumen. The thickness of strip shall not be less than 1.5 mm and width not less than 25 mm for flooring.

14.8.1 General construction - The terrazzo finish normally consists of the topping and an under layer and is laid over a layer of base concrete or cushioning layer. The arrangement of terrazzo finish laid directly over the ground shall be as various layers shown in Fig. 1 and when laid on structural slab, the arrangement shall be as shown in Fig. 2. The sub-base shall be well consolidated layer of earth is preferably sand. The cushioning layer shall preferably be lime concrete. The base concrete shall be lean cement concrete of 1510 mix or lime concrete.

14.8.1.2 The thickness of base concrete shall be not less than 100 mm and of cushioning layer not less than 75 mm. The combined thickness of under layer and topping for flooring and dado/skirting shall not be less than 30 mm and 20 mm respectively. The thickness of terrazzo topping shall be not less than the following depending upon the size of chips used.

Size of chips mm	Minimum thickness Mm
1 to 2 2 to 4	6
4 to 7	9
7 to 10	12

Where chips of larger size than 10 mm are used, the minimum thickness of topping shall be not less than one and one-third times the maximum size of chips.

14.8.1.3 Mix proportions

a) The under layer shall be of cement concrete mix 12 4 by volume, the maximum size of aggregate shall not exceed 10 mm.

b) The mix for terrazzo topping shall consist of cement with or without pigments, marble powder, marble aggregates and water. The proportions of cement and marble powder shall be three parts of cement and one part of powder by mass. For every part of cement marble powder mix, the proportion of aggregates shall be as follows depending on the size of aggregates .

Size of aggregates parts (mm)	Proportion of aggregate of binder mix
1 to 7	One and three-fourths
7 to 15 15 to 22	One and one-half

The aggregates may be of required colour or may be a mix of aggregates of different colours in the required proportions. The proportions of cement shall be inclusive of any pigments added to cement. The proportions in which pigments are mixed with cement or white cement to obtain different colours for the binder shall be as specified in Table 1.

14.8.1.4 Size of panels

a) While laying the floor the joints in flooring shall always coincide with the expansion joints, if any, in the structural slab so that any movement of the base will be in the joint in the flooring instead of forming uncontrolled cracks.

b) Differential shrinkage or expansion between terrazzo and the sub-floor may cause cracks in the flooring and floor joints shall be formed to that the positions of such cracks are controlled. The floor both while laying the under layer and later on the topping shall be divided into panels not exceeding 2 m2 so as to reduce the risk of cracking. The joints shall be so located that the longer dimension of any panel does not exceed 2 m. The panel shall preferably be separated by means of dividing strips. However where butt joints are provided, the bays shall be laid alternately allowing for an interval for at least 24 h between the laying of adjacent bays.

14.8.2 Preparatory work

14.8.2.1 Mixing of materials

a) Mixing of materials is of great importance, for if this is not done thoroughly the work will not have a uniform appearance. If done manually the mixing shall preferably be done in a trough or a tub. With a view to avoid variation in colour the complete quantities of cement and pigment required for one operation shall be mixed at the beginning of work and stored properly.

b) Where different coloured chips are used, they shall be first well mixed in required proportions of various colours and sizes.

c) Coloured cement may be procured as ready mixed material or mixed at site ; in the latter case the pigment and cement in the required proportions shall be mixed thoroughly and sieved before further mixing with marble powder and aggregates.

d) The coloured cement shall be thoroughly mixed in dry state with marble powder. The binder so obtained and the mix of chips shall then be mixed dry together as given .

e) While mixing the aggregates, care shall be taken not to get the materials into a heap, as this would result in the coarsest chips falling to the edge of the heap and cement

working to the centre at the bottom. The material shall be kept, as far as possible, in an even layer during mixing.

f) After the materials have been thoroughly mixed in the dry state, water shall be added in small quantities, preferably in a fine spray, while the materials are being mixed until the proper consistency is obtained. The mixture shall be plastic but not so wet that it will flow ; a rough indication for the addition of proper quantity of water in the mix is that it shall be capable of being moulded when squeezed in hard without water flowing out. A high water cement ratio will produce a mixture with a high dry shrinkage.

g) Machine mixing may preferably be used but the common type of concrete mixer is not as suitable for terrazzo work as the mixer specially made for this purpose, in which segregation is prevented by blades with a lifting as well as rotating movement. Only constant work justifies the installation of such special machines.

h) The mix shall be used in the work within half an hour of the addition of water during preparation.

14.8.3 Under layer - Cement concrete of specified mix shall be used and the specifications as given 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 metre. Cement slurry @ 2.00 kg per sqm shall be applied before laying of under layer over the cement concrete / RCC base.

14.8.4 Fixing of strips - 4 mm thick glass strips or 5 mm thick plain asbestos sheet or 2 mm thick PVC strips / aluminium strips /brass strips unless otherwise specified shall be fixed with their top at proper level to required slope. Strips of stone or marble or of any other material of specified thickness can also be used if specifically required. The fixing and laying shall be as specified.

14.8.5 Top layer

14.8.5.1 Mortar - The mix for terrazzo topping 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 2 below

The marble chips shall be white or pink Makran, black Bhainslana, Chittoor black, Jaisalmer Yellow, Baroda green, Dehradun white, Chittoor pink, yellow Patam cherala (Madras), grey Gadu (Surat), Chittoor green and yellow and Alwar black or as specified. It shall be hard, sound, dense and homogeneous in 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 size of marble aggregates (marble chips) shall be as shown in Table 2 below .

Table 2

Grade No	Size of aggregates In (mm)	Proportion of aggregates to binder mix	Minimum thickness of top layer (mm)
00	1-2	1.75:1	6
0	2-4	1.75:1	9
1	4-7	1.25:1	9
2	7-10	1.5:1	12

Where aggregate of size larger than 10 mm are used, the minimum thickness of topping shall not be less than 1-1/2 times the maximum size of the chips. Where large size chips such as 20 mm or 25 mm 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.

Before starting the work, the contractor shall get the sample of marble chips approved by the engineer. The cement to be used shall be ordinary grey cement, white cement, coloured cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item in the ratio to get the required shade as ordered by the engineer. 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 shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogeneous and stiff and to contain just sufficient water to make it workable.

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 commenced. 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.

14.8.6 Polishing, curing and finishing - Polishing shall be done by machine. About 36 hours after laying the top layer, 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 cure for 5 to 7 days and then rubbed with machine fitted with fine grit blocks (No. 120). 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 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.

Where use of machine for polishing is not feasible or possible, 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. After the final polish either by machine or by hand, oxalic acid shall be dusted over the surface @ 33 gm per square metre sprinkled with water and rubbed hard with a nemdah block (Pade of woollen rags). The following day, the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

Curing shall be done by suitable means such as laying moist saw dust or ponding water.

14.8.7 Precautions - Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to WC's squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4 degree C. The concrete placed shall be protected against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38 degree C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the engineer.

14.8.8 Measurements - 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.

14.8.8.1 The thickness of the under layer shall be measured correct to a cm. The thickness of top layer shall not be less than that specified.

No deduction shall be made, nor extra paid for voids not exceeding 0.20 square metre. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard.

14.8.8.2 Terrazzo (Marble Chips) flooring laid as floor borders, margins and similar bands up to 30 cm width and on staircase treads shall be measured under the item of terrazzo flooring but extra shall be paid for such work. This extra in the case of staircase treads shall include the cost of forming the nosing also. However, moulded nosing shall be paid extra in running metres except where otherwise stated, returned moulded ends and angles to mouldings 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 metres for this purpose.

14.8.8.3 Dividing strips inserted in terrazzo to form bays, patterns shall be described stating the materials, its width and thickness and measured in running metres.

14.8.8.4 Special surface finishes to treads, risers and the ends of concrete steps and the like shall be measured separately and given in square metres and shall include form work, if required.

14.8.9 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 aluminium or of any other material used for making panels, which shall be paid for separately.

14.9 SPECIFICATIONS FOR TERRAZZO (MARBLE CHIPS) SKIRTING IN SITU

14.9.1 Under coat - The under coat of skirting shall be of cement plaster of the thickness and mix described in the item. Specifications as given under 14.5.0, 14.5.1, & 14.5.2 shall apply. As regards application, the work shall be carried out in the manner as described under 14.5.3 except that the under coat shall be finished rough with a scratching tool to form a key for the top coat.

14.9.2 Top coat - The Specifications shall hold good as far as applicable and shall include cutting to line and fair finish to top edges of terrazzo and polishing.

14.9.3 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 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 specified.

14.9.4 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.

14.9.5 Rates - The rate shall include the cost of all materials and labour involved in all the operations described above.

14.11 SPECIFICATIONS FOR TERRAZZO TILE FLOORING

14.11.1 Terrazzo tiles - Terrazzo tiles shall generally conform to IS 1237. Requirements and methods of testing of tiles are described in Annexure 14-A.2. Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of wearing layer. The size of tiles shall be as given in Table 3 or as shown in the drawings or as required by the engineer. 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 3

Length Nominal	Breadth nominal	Thickness not less than
200 mm	200 mm	20 mm
250 mm	250 mm	22 mm
300 mm	300 mm	25 mm

14.11.1.2 Tolerance - Tolerances on length and breadth shall be plus or minus one millimetre, and tolerance on thickness shall be plus 5 mm. The range of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and 3 mm on thickness.

14.11.1.3The tiles shall be manufactured in a factory under pressure process subjected to hydraulic pressure of not less than 140 kg per square centimetre and shall not be given the initial grinding with machine and grouting of the wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of wearing layer may be rounded.

14.11.1.4 The proportion of cement to aggregate in the backing of tiles shall be not leaner than 13 by weight. Where colouring material is used in the wearing layer, it shall not exceed 10 per cent by weight of cement used in the mix.
14.11.1.5 The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips from the smallest up to 6 mm and also, not less than 5 mm for size of marble chips ranging from the smallest up to 12 mm, and not less than 6 mm for size of marble chips varying from the smallest up to 20 mm.

4.11.2 Laying - 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 lime mortar of any of the following specifications prepared in conformity with provisions in relevant para of chapter on 'Mortar'.
(a) 112 (1 lime putty 1 surkhi 2 coarse sand), or
(b) 13 (1 lime putty 3 surkhi), or
(c) 13 (1 lime putty 3 coarse sand)

The ingredients shall be thoroughly mixed by volume in dry form. Care shall be taken to ensure that there are no hard lumps present. Water shall then be added and the ingredients thoroughly mixed.

Where lime putty of proper quality is not available, cement mortar 14 (1 cement 4 coarse sand) bedding may also be used with prior approval of the engineer.

The average thickness of the bedding mortar shall be 30 mm and the thickness at any place shall not be less than 10 mm.

14.11.2.2 Lime 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 at the rate of 4.4 kg of cement per square metre 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 1.5 mm and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge at least 2 metre long, 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.

After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

14.11.3 Curing, polishing and finishing

14.11.3.1The 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.

14.11.3.2 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).

14.11.3.3 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.

14.11.3.4 For small areas or where circumstances so require, hand polishing may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used

First grinding – coarse grade stone (No. 60).
Second grinding – medium grade (No. 80)
Final grinding – fine grade (No. 120).

In all other respects, the process shall be similar as for machine polishing.

14.11.3.5 After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad or wooden rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

14.11.3.6 If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

14.11.3.7 The finished floor shall not sound hollow when topped with a wooden mallet.

14.11.4 Measurements

14.11.4.1 Terrazzo tiles flooring with tiles manufactured from ordinary grey cement without pigment and coloured terrazzo tile flooring shall be measured separately and classified. Terrazzo tile flooring shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm before laying skirting, dado or wall plaster shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room or courtyard.

14.11.4.2 Terrazzo tile flooring laid in floor borders and similar band shall be measured under the item of terrazzo tile flooring. Nothing extra shall be laid in respect of these and similar bands formed of half size of multiples of half size standard tiles or other uncut tiles.

14.11.4.3 Treads of stairs and steps paved with tiles without nosing, shall also be measured under flooring. Moulded nosing shall be paid in running metre except where otherwise stated, returned moulded ends the and angles to mouldings shall be included in the description. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm.

14.11.5 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.

14.12 SPECIFICATIONS FOR TERRAZZO TILES IN RISERS OF STEPS, SKIRTING AND DADO

14.12.1 The terrazzo tiles shall be as specified, 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 into 12 mm and not less than 6 mm for size of chips varying from the smallest up to 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 Annexure 14-A.2, shall not apply when the tiles used are less than 20 mm thick.

14.12.2 Preparation of surface - The specifications for this shall be same as specified in 14.6.2

14.12.3 Laying - 12 mm thick plaster of cement mortar 13 (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 centres 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 be as fine as possible. Top of skirting or dado shall be truly horizontal 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 (swan) to the required size and their edges rubbed smooth.

14.12.4 Curing, polishing and finishing - The specifications shall hold good as far as applicable. Polishing shall be done only with hand.

14.12.5 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 cms, as in the case of dado and on walls, the height shall be paid for separately. The area shall be calculated in square metre, 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.

14.12.6 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.

14.13 SPECIFICATIONS FOR CHEQUERED TILE FLOORING

14.13.1 Chequered tiles - The tiles shall be of nominal sizes such as 20 x 20 cm 25 x 25 cm and 30 x 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the engineer. 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 be not less than 22 mm. The grooves in the chequers shall be uniform and straight. The 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.
The terrazzo tiles shall be given the first grinding with machine before delivery to site.

The tiles shall conform to the specification for plain cement concrete or terrazzo tiles in respect of method of manufacture and the mix of the backing and wearing layers.

14.13.2 Laying , curing, polishing and finishing - Laying, curing, Polishing and Finishing shall be as specified in 14.11.2 and 14.11.3 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.

14.13.3 Measurement and rate - Shall be as specified in 14.11.4 and 14.11.5.

14.14 SPECIFICATIONS FOR CHEQUERED TILES FLOORING IN STAIR TREADS

14.14.1 Chequered tiles - The specifications for tiles shall be as specified 14.13.1 except in the following respects

1) The length of the tiles including nosing shall be as specified.
2) The nosing edge of the tile shall be rounded.
3) The minimum thickness of the tile shall be 30 mm.
4) 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 centres not exceeding 25 mm. Beyond that the tiles shall have the normal chequer pattern.
5) The nosing shall also have the same wearing layer as the top.

14.14.2 Preparation of surface and laying

14.14.2.1 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 lime mortar of either 111 (1 lime putty 1 surkhi 1 coarse sand) or 14 (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 per square metre over each tread. Tiles shall be washed cleaned and shall be fixed in this grout 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.

14.14.2.2 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.

14.14.2.3 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 a straight and true joints.

14.14.2.4 After the tiles have been laid surplus cement grout shall be cleaned off.

14.14.3 Curing, polishing and finishing - The specifications shall be as described 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.

14.14.4 Measurements - Chequered tiles on stair treads shall be measured in square metre 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 laid, 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 metre.

14.14.5 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 cutting the tiles to suit the size of treads and also for nosing.

14.15 SPECIFICATIONS FOR GLAZED TILE FLOORING

14.15.1 White glazed tiles - The tiles shall be of approved make and shall generally conform to IS 777. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as indicated in Appendix of IS 777.

The tiles shall be square or rectangular of nominal size such as 150 x 150 mm, 100 x 100 mm, 100 x 200 mm or as directed by the engineer. The thickness of the tiles shall be 5 mm, or 6 mm as specified. The length of all four sides shall be measured correct to 0.1 mm and average length breadth shall not vary more than $\pm$ 0.8 mm from specified dimension. The variation of individual dimension from average value of length/breadth shall not exceed $\pm$ 0.5 mm. Tolerance in thickness shall be $\pm$ 0.4 mm.

Note 1 **-** Where tiles of nominal sizes of 150 x 150 mm or 100 x 100 mm are not available tiles of nominal sizes 152 mm x 152 mm or 108 mm x 108 mm may be allowed to be used with prior approval of the engineer.

Note 2 **-** The actual size of tiles supplied shall be 1 mm less so that with 1 mm joint, the tile when laid shall conform to the nominal size.

The top surface of the tiles shall be glazed and glaze 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. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50 per cent of the surface area of the edges.

14.15.2 Coloured tiles - Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

14.15.3 Decorative tiles - The type and size of the decorative tiles shall be as follows

i) Decorated white black ground tiles

The size of these tiles shall be 152 x 152 x 6 mm and / or 108 x 108 x 6 mm.

ii) Decorated and having coloured back ground

The sizes of the tiles shall be 152 x 152 x 6 mm and / or 108 x 108 x 6 mm.

14.15.4 Preparation of surface and laying

14.15.4.1 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 13 (1 cement 3 coarse sand) or as specified. The average thickness of the bedding shall be 10 mm while the thickness under any portion of the tiles shall not be less than 5 mm.

14.15.4.2 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.

14.15.4.3 Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over such an area as would accommodate about twenty tiles. 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 woodrn 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.

14.15.4.4 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.

14.15.4.5 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.

14.15.4.6 After tiles have been laid surplus cement slurry shall be cleaned off.

14.15.5 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. 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.

14.15.6 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 deductions shall be made not extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

14.15.7 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.
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.

14.16 SPECIFICATIONS FOR GLAZED TILES IN SKIRTING AND DADO

14.16.1 The tiles shall be of approved make and shall generally conform to IS 777. The tiles shall be of earthenware 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 untility.

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 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 up to 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawlings or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. 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. There may be more than one colour on a tile.

14.16.1 (a) Dimensions and tolerances - Glazed earthenware tiles shall be made square or rectangular in sizes such as 149 x 149 mm and 99 x 99mm or 99 x 199 mm or as specified and shall be straight or cushion edge type.

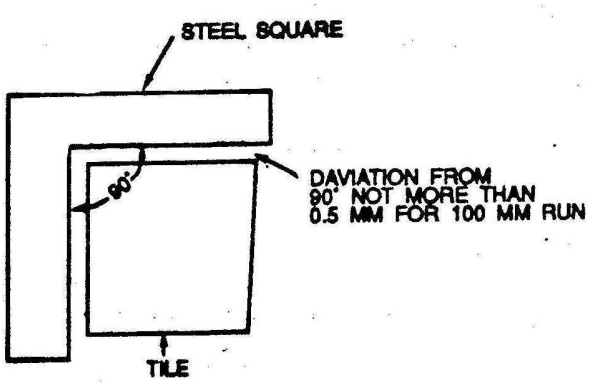
Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

Note - Commonly manufactured sizes include 108 x 108 mm, 152 x 152 mm, 200 x 200 mm, 200 x 150 mm and 200 x 100 mm.

The thickness of the tiles shall be 5 mm or 6 mm as specified.

The dimensions of fittings associated with the glazed tiles namely cove base, round edge tile, angles corner cups, ridge and legs, cronices 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.



Method of checking squareness of tiles

Fig. A – Trueness of Shape (Squareness)

14.16.1(b) Tolerances

Facial dimensions – The lengths of all the four sides of the tile shall be measured to the nearest 0.1 mm. The average value of lengths/breadth shall not vary more than ± 0.8 mm from the above specified dimension.

The variation of individual dimensions from average value of length / breadth shall not exceed ± 0.5 mm. Tolerances on thickness shall be ± 0.4 mm.

Tiles shall be checked for squareness and warpage as described thereafter.

14.16.1 (c) Trueness of shape (Squareness) - Any variation from a right angle in the angle contained by any two adjoining sides shall be limited so that if a builder's steel square is placed against the angle, the distance between the inner edge of the square and the adjacent side of the tile or fitting shall not be more than 0.5 mm per 100 mm run.

14.16.1 (d) Warpage - The tiles when tested for warpage on the edges and on the diagonal as per Appendix – A – IS 777 shall not have warpage exceeding the value as specified below

Size of tile (mm)	Warpage (mm)
149 x 149	- 0.4 + 0.7
99 x 99	- 0.3 + 0.5

14.16.1(e) Performance requirements water absorption - The average water absorption of the tiles when tested and evaluated in accordance with IS 777 shall not exceed 20 per cent.

Crazing - Tiles subjected to two cycles of crazing test as per IS 777 shall not show any sign of crazing.

Impact resistance - Tiles when tested for impact resistance as per IS 777 shall remain intact, apart from surface marking.

Chemical resistance - When tested as per IS 777, the glazed surface of tiles and / or the fittings having a white or cream coloured glossy glaze shall show no modification.

14.16.2 Preparation of surfaces - The joints shall be raked out to a depth of at least 15 mm in masonry walls.

In case of concrete walls, 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.

14.16.3 Laying - 12 mm thick plaster of cement mortar 13 (1 cement 3 coarse sand) mix 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. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. 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. 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.

14.16.4 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.

14.16.5 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 metre, 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.

In addition to payment for areas of skirting and dado, specials such as coves, internal and external angles and beads shall be measured separately and paid for in running metres. Cornices shall also be similarly measured for payment in running metres. 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.

14.16.6 Rates - The rate shall include the cost of all materials and labour involved in all the operations described above. 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 metres separately.

14.18 SPECIFICATIONS FOR MARBLE FLOORING

14.18.1 Marble - It shall be as specified in section 5

14.18.2 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 slab 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 machine 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 20, 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.

14.18.3 Laying

14.18.3.1 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 14 (1 cement 4 coarse sand) or with lime mortar 111 (1 lime putty 1 surkhi 1 coarse sand) as given in the description of the item.

14.18.3.2 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.

14.18.3.3 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 as 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 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.

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.

14.18.3.4 The slabs shall be matched as shown in drawings or as instructed by the engineer.
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.

14.18.4 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 except that cement slurry with or without pigments shall not be applied on the surface before each polishing.

14.18.5 Measurements - Marble stone flooring with different kind of marble shall be measured separately and in square metre 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 metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. 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 metre and paid for extra. The width of treads shall be measured from the outer edge of the nosing, as laid, before providing the riser.

14.18.6 Rate - The rate shall include the cost of all materials and labour involved in all the operations described above.

14.19 SPECIFICATIONS FOR MARBLE STONE IN RISERS OF STEPS AND SKIRTING

14.19.1 Marble Stone Slabs and Dressing of Slabs shall be as specified, except that the thickness of slabs shall be 30 mm. A tolerance of ± 3 mm shall be allowed, unless otherwise specified in the description of the item.

14.19.2 Preparation of surface - It shall be as specified 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.

14.19.3 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 in to 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 13 (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. 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.

14.19.4 Curing, polishing and finishing - It shall be as specified in 14.11.3 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.

14.19.5 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 1 mm. The areas shall be calculated in square metre 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 up to 25 mm or as “Marble Work” in Jambs, walls, columns and other plain work if the thickness is more.

14.19.6 Rate - The rate shall include the cost of all materials and labour involved in all the operations described above.

14.20 SPECIFICATIONS FOR KOTA STONE FLOORING

14.20.1 Kota stone slabs - The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the engineer.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the engineer.

14.20.2 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 $\pm$ 2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of $\pm$ 5 mm for hand cut slabs and $\pm$ 2 mm for machine cut slabs shall be allowed.

14.20.3 Preparation of surface and laying - The specification shall be as described in 14.18.3 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.

14.20.4 Polishing and finishing - The specifications shall be as described in 14.11.3 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.

14.20.5 Measurements and rates - These shall be as described above in 14.18.5 & 14.18.6.

14.21 SPECIFICATIONS FOR KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO

14.21.1 Kota stone slabs and dressing shall be as specified except that the thickness of the slabs shall be 25 mm or as specified in the description of the item. The slabs may be of uniform size if required.

14.21.2 Preparation of surface shall be as specified.

14.21.3 Laying shall be as specified in 14.19.3 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

14.21.4 Curing, polishing and furnishing shall be as specified in 14.19.4 except that first polishing with coarse grade carborundum stone shall not be done.

14.21.5 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 metre correct to two places of decimal.

Lining of pillars etc. shall also be measured under this item.

14.21.6 Rate - The rate shall include the cost of all materials and labour involved in all the operations described above.

SECTION – 9
WOODWORK

9.1 GENERAL SPECIFICATIONS FOR TIMBER USED IN BUILDINGS

9.1.1 Timbers generally used in buildings are either of solid timber or panel products like plywood, particle board, etc. The major use is in door and window frames and their shutters, furniture and the like. It is also used in structures specially in hilly regions where timber is abundantly available and other common building materials like brick are not easy to come by.

9.1.2 India has around two hundred species of commercial timber grown in different parts of the country. For quite sometime timber was transported over long distances for some specific services even when species suitable for the purpose would be secured from nearby sources. The reason apparently appears to be the misconception that in timber there are primary species (teak) and secondary species. No such classification exists and it is a misnomer. All species can used, only each species has different end use. Some species are even stronger in cumulative properties than teak. IS 3991963 classifies commercial timber and their distribution in India along with different end uses. Therefore it is necessary to check locally available timber for building purposes before specifying the species for woodwork.

9.1.3 Moisture content is an important requirement for use of timber in woodwork. Moisture content affects its workability, size, etc. the moisture content of timber changes from season to season depending on atmospheric humidity. The application of a finish (paint or varnish) reduces the change in moisture content with changes in humidity in the atmosphere. IS 2871993 governs the recommendations for maximum permissible moisture content for timber used for different purposes.

9.1.4 For actual end use seasoning and treatment of timber are necessary. Seasoning will help in the control of moisture and it should be done as per IS 11411993; and preservation as per IS 4011982.

9.2 Classification of timber

9.2.1 Zonal distribution

IS 3991963 details the zonal distribution of common commercial and timber of India, classified according to their various end uses and gives information on availability and on some of the other properties of these timbers. The uses, include

a) Constructional purpose, including building construction, piles, bridges, poles, railways sleepers, etc; and
b) Furniture and cabinet making.

India is divided into five zones for convenience in tabulating the information on timber. The zones are

Zone 1 - Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana and Rajasthan.

Zone 2 - Assam, Manipur, Tripura, West Bengal, Bihar, Orrisa, Mizoram, Arunachal Pradesh, Nagaland, Sikkim, Haryana, Bhutan, Andamans.

Zone 3 - Madhya Pradesh, Vidharba areas of Maharastra and north east part of Andhra Pradesh (Godavari Delata area).

Zone 4 - Maharastra (except Vidharbha area), Gujarat, and north west part of Karnataka.

Zone 5 - Tamil Nadu, Pondichery, Andhra Pradesh (except Godhavari Delta area), Kerala and Karnataka (except north west part).

9.2.2 Information on timber

Tables in IS 399 1963 give information on the following aspects of timbers available in these zones.

a) **Availability** - Availability of commercial timber is categorized under three classes as given below

X - Most common, 1400 cu.m and more per year
Y - Common, 350 – 1400 cu.m per year
Z - Less common. Below 350 cu.m per year.

b) Mass per cubic metre– The average mass per cubic metre at 12 percent moisture content for all timbers.

c) Durability - The figures of durability are based on grave yard tests carried out on 60 cm X 5 cm X 5 cm specimens and are categorized as below

High – Timber having, an average life of 120 months and over
Moderate – Timber having an average life between 60 to 120 months.
Low – Timber having an average life less than 120 months.

d) Treatability – Treatability, reflecting the resistance offered by the heartwood to the penetration of preservation fluid under pressure of 10.5 kg/cm² is classified as below

a – Heartwood easily treatable
b – Heartwood treatable, but complete penetration of preservative not always obtained
c – Heartwood only partially treatable
d – Heartwood refractory to treatment
e – Heartwood very refractory to treatment, penetration being practically nil from side or end

e) Compressive strength coefficient – The compressive strength coefficient is arrived at by grouping the various important mechanical properties of timber that may come into play for any particular use and giving due weightage to the relative important of these properties.

9.2.2.1 **The handbook SP 33 (S & T)** 1986 covers the engineering aspects of use timber.

9.2.2.2 Timber species be identified by using IS 49701973 [keys for identification of commercial timbers] around 50 cards are available for identifying species.

9.2.2.3 Timber may be graded on the basis of defects as per IS 65341971 which gives guidelines of grading and inspection of timber.

9.2.2.4 Since publication of IS 3991963 further work has been done in identifying species of timber suitable for doors and window shutters and frames; and for furniture and cabinets. These are covered in IS 12896 1990 for shutters and frames and IS 136221993 for furniture and cabinets. These additional species have been brought in for these end uses.

9.3 Quality of different varieties of timber available in Karnataka state

9.3.1 **Teak** – It is a moderately hard. The sapwood is white. The heartwood is pale brown or dark golden yellow, darkening with age. On seasoning, the wood turns brown to dark brown or nearly black with long age. When once it is seasoned it does not split, crack, shrinks, or warp or alter its shape. It floats in water. It possesses a fragment oil with a strong scent which prevents the white ants from attacking the heartwood and preserves the same from the effects of weather. In buildings, it will for ever and as sleepers for atleast 20 years. It does not corrode iron.

9.3.2 **Honne** – It grows to great dimensions from 3 to 4.5 meters in grith with bole of 9 to 12 meters and a height of 25 meters. The sapwood is small. Heartwood is yellow to grey brown with dark streaks running the whole length of the tree. It is very hard and close grained, durable, seasons well and is not affected by damp and changes of temperature. It can easily be worked to a good surface and it takes a fine polish.

9.3.3 **Nandi or Benteak** – This tree grows to a great size attaining a height of 30 meters and over with a girth of 2.5 to 3 meters and a clean bole of 12 to 15 meters and yields one of the best timbers of the reserved trees of Karnataka. It is of dull red or reddish brown colour, straight gained, moderately hard, very elastic and tough, durable especially in salt water. It has to be carefully seasoned.

9.3.4 **Rosewood** – This grows to large dimensions with a bole of 15 to 25 meters and a girth of 3 to 4 meters or even 5 meters. The sapwood is yellow and small. It is very hard, durable, strong, heavy and cross grained. It is stronger than teak. It takes a fine polish which gives it an extremely handsome appearance.

9.3.5 **White Cedar** – This is close grained yellowish, hard wood with elastic fibres. The bark is grey hard and covered with white warts. It is strong and durable but sometimes warps even after long seasoning. It has a strong cedar-like smell and a fine satin lusture. Takes fine polish.

9.3.6 **Karachi or Kamara or Anjan tree** – This is fine grained wood, dark red or brown in colour, streaked with black bands often with purplish tinge and does not warp. It splits easily when struck tangentially but very difficult in a radial section. It seasons with difficulty and is subjected to fine cup and heart shakes.

9.3.7 **Shivani** – The bark of this tree is very pale, smooth and covered with lenticles. The wood is yellowish or reddish white with a glossy lusture, smooth close and even grained. It is strong and durable but light and insects do not attack. It seasons well and evenly and does not warp or shrink. It presents a good appearance like ivory and takes readily paint or varnish.

9.3.8 **Jali Mara or Babul** – This wood is hard pinkish white turning red or dark reddish brown on exposure to the air, mottles with dark streaks. It is hard, tough, close grained, very durable if seasoned. It is fairly heavy, short fibered and somewhat brittle to work but takes a smooth surface and good polish.

9.3.9 **Yettiga Heddi** – This wood is moderately hard and even grained. It is lemon yellow in colour when cut, turning yellow grey on exposure. It works very easily and takes a good polish. It seasons well and is durable, but somewhat liable to warp and crack.

9.3.10 **Burga, Yelagada Mara, Silk Cotton tree** – This tree grows 25 to 35 meters in height and to a girth of 4 to 5 meters. The wood is greyish white turning to dark brown and gets discoloured when seasoned. The wood is soft, coarse-grained and porous. It decays rapidly on exposures, but lasts well under water. It seasons quickly and is easily worked. It is easily attacked by white ants.

9.3.11 **Karimathi** – This grows to height of 25 to 30 meters with a grith of 3 to 4 meters and a bole of 12 to 15 meters. The sapwood is reddish white. The heartwood is freshly cut, turning grey on exposure. This timber is strong, difficult to saw and plane. It splits unless thoroughly seasoned, but somewhat difficult to season. It is durable specially under water.

9.3.12 **Hunal** – The wood is grey or pale brown, even and close-grained, cutting to a smooth surface, prettily mottled, very hard and fairly durable. The wood is good, but somewhat liable to split and not very difficult to work. It is improved by being kept under water. It is liable to the attack of white ants when burried in the ground.

9.3.13 **Thadsal or Dadsal** – The wood is red, brown in colour. It is very elastic, moderately hard and straight grained with long fibre. It is smooth, takes a fine polish and can be easily worked. It is durable and seasons fairly well.

9.3.14 **Holematti, Bilimatti** – The wood is dark brown with darker coloured streaks and very hard. It is apt to split in seasoning and is not easy to work.

9.3.15 **Bagemara or Thiruchal or Bellali** – The wood is dark brown with paler or dark reddish brown streaks, mottled and shining. The wood is hard, close grained. It is tough and fairly durable. It seasons well and easy to work.

9.3.16 **Jack or Halasu** – The wood is bright yellow in colour and mottled when freshly cut, darkening on exposure to orange-brown. It is moderately hard and close grained. It seasons readily and does not warp or split. It works easily and is fairly durable. It takes a good polish. It stands well under water.

9.3.17 **Haiga** – The wood is brown, hard, close-grained and smooth. It is a valuable timber and is considered as one of the best timbers in Tinnevelly.

9.3.18 **Tamarind or Hunse Mara** – The tree grows to large dimensions. The stem is seldom straight being mostly short, knotty and thick while the crown is unbraceous. The heartwood forms only a very small portion of the stem. It is dark, purplish brown, hard, close-grained and very durable.

9.3.19 **Sadhupa or Dhupada** – The tree grows to great height with a clear bole of 20 to 25 meters. The wood is grey to light grey in colour, moderately hard, working freely to a smooth surface and presenting a easy appearance if well planed.

9.3.20 **Gandhagarige or Red Cedar Wood** – Bright reddish to red, shining, close and even grained, soft and sweet scented with prominent lines on the longitudinal cut, representing the pores. It is lighter and works to a smooth surface. It takes fine polish but requires a considerable filling before polishing and absorbs much of the polish. The timber seasons quickly and is durable under cover. It does not warp or split but shrinks and expands with variations of temperature and moisture. It is not attacked by white ants.

9.3.21 **Kadavala or Kadaga** – The wood is yellowish or pinkish brown. It is close-grained, moderately hard and durable if not exposed to wet. It is easy to cut and works to a smooth surface. In seasoning, it is liable to fine longitudinal cracks which, however, do not penetrate deep into the log.

9.3.22 **Poonspar or Surahonne Tree** – The tree attains a height of about 40 meters and more with a girth of 4 to 5 meters. The bark is furrowed with long longitudinal cracks. The wood is of reddish-brown colour and of a streaky and wavy appearance. It is very elastic and seasons fairly well under water. The wood is moderately hard, coarse-grained, strong and fairly durable.

9.3.23 **Channangi** – The wood is grey-brown in colour very hard, cutting to a smooth shinning surface, durable and not readily attacked by white ants, it is moderately heavy, difficult to work and rather liable to split. It is close-grained, straight and elastic.

9.3.24 **Ippe** – It attains a height of 30 meters with a girth of 3 to 5 meters. The wood is moderately hard and close-grained. It is heavy, close and straight grained, very flexible and durable.

9.3.25 **Jamba (Inga Xylocarpa or Xylia Xylocarpa)** – This is also known as the iron wood of Arracan, found throught S.India. Very superior quality wood, heavy, hard, close-grained and durable and of a very dark red colour. Not easily worked and resists nails. Extensively used for bridgework, posts, piles, etc. good for sleepers and paving blocks. Plentiful in Mangalore, Udupi & U.K districts.

9.3.26 **Jambe mara** – It grows to a height of 25 meters with a bole 9 meters and a girth of 2.0 to 2.5 meters. The wood is dark brown or reddish brown in colour, annual rings darker but not distinct. It is tough and strong, very hard and difficult to saw especially the seasoned timber. It is cross and coarse-grained and somewhat twisted, cutting to a smooth shinning surface which takes paints or varnish readily and well. It is liable to crack and warp very badly while seasoning.

9.3.27 **Nerale** - The tree attains a girth of 3 to 4 meters with a clear bole of about 12 meters. The wood is reddish brown in colour, coarse, moderately hard, darker near the centre, but there is no distinct heartwood. It is tough and fairly durable, not attacked by white ants. It is sometimes liable to warp in seasoning.

9.3.28 **Surahonne or Kal-Honne** – It grows to a girth of 2 meters with a clean bole of 6 to 8 meters. Bark is light brown. Sapwood is small and gray. The wood is grey to greyish brown, mottled handsome, close-grained, very elastic, tough and hard. It takes a good polish. It seasons well and not liable to warp, nor is subject to the attacks of white ants.

9.3.29 **Mavu or Mango** – The wood in older trees is greyish brown to dark brown in colour, streaks with dark coloured tissues, hard, durable and lasts well in water. It is coarse-gained and twisted in fibre and soft in younger trees, readily eaten by insects. It seasons well and does not warp or shrink when joined.

9.3.30 **Mashwal of Satin Wood (Huragalu)** – The wood is very hard, lemon yellow or cream coloured. The inner wood is darker than the outer, but no distinct heartwood. It is fragrant and has a fine satiny lustre. A planed surface presents a very smooth shining appearance, often handsomely figured. It is durable and hard but is somewhat liable to split. It takes a fine polish. It seasons moderately well and stands immersion in water. It loses its beauty with age unless it is protected by a coat of fine varnish.

9.3.31 **Nagasampige** – Cultivated in gardens and near temples for the sake of its sweet scent and large flowers. Bark reddish brown, peeling off in thin flat flakes, having a slightly roughened surface. The wood somewhat resembles calophyllum ; but much harder and heavier. It is dark red in colour. It is very difficult to work. It should be used well seasoned as it is liable to warp and split.

9.3.32 **Bakul, Ranja or Pagademara** – The wood is very hard even grained. Sapwood reddish brown and heartwood dark-red. It is strong, durable of good colour and quality, but heavy. It works to a smooth surface, seasons well and takes very fine polish, but is difficult to saw and work.

9.3.33 **Malbar Mahoghani, Yennemara** – Bark is dark-brown and green, rather rough. The wood is dark or reddish brown to red, straight and even grained, moderately hard and takes a fine polish. From the wood exudes a red sticky resin.

9.3.34 **Nirvan Teak or Hole Dasaval** – It is called the “pride of India” on account of its beautiful pink flowers. The tree yields an excellent timber but is not known outside its local limits more on account if its very little supply. The wood is light red being brighter when freshly cut, hard, durable and smooth. It lasts well under water and is able to stand rough wear and tear. It works easily and takes a fine polish.

9.3.35 **White Siris, Bellatte or Bilewate** – The sapwood is large, yellow white, not durable. Heartwood brown shinning with alternate belts of darker and lighter colour, often indistinguishable from that of Bagemara or Thirchal. The wood is straight and even grained, seasons well and the heartwood is durable.

9.3.36 **Kendal, Sagade** – It is a useful tree as it gets new leaves before the hot season and on this account it is known as forester's friend. It attains a height of 12 to 15 meters and girth of 2 to 3 meters. The wood is extremely hard light pinkish-brown or red and cross-grained. It is tough, strong and durable, season well, though little liable to crack. It is a very heavy timber and possess considerable power to withstand the attacks of marine bores. It takes a good polish.

9.3.37 **Mukarthi** – A small tree, preferring clayey soils generally. It is found not to grow more than 1.5 meters in girth. The wood is moderately hard, even and close grained and light brown, often with a red tinge. The outer wood is white. It takes a good polish. It seasons well and is durable, but thin planks are somewhat liable to warp.

The root is said to be a specific against snake bites and the bark used in native medicine is said to be a virulent poison.

9.3.38 **Kadaga, Kadamba or Nirabale –** The wood is white with a yellowish tinge, soft and even grained. It has a slight unpleasent smell.

9.3.39 **Havalige** – It attains a height of 30 to 45 meters with a bole of 30 meters. The wood is light-red and straight-gained. It is moderately hard. Some trees split splendidly into shingles but others are found to be totally unfit for the purpose.

9.3.40 **Naihalasu** – The tree attains a girth of 3 to 4 meters with a clean bole of 10 to 15 meters. The wood is hard red and very handsome. The medullary rays are regular, very broad and prominent forming a handsome silver grain. The wood seasons well, and takes a very fine polish.

9.3.41 **Bilvapatre, Bilpatre** – The wood is yellowish greyish white in colour with a strong aromatic scent when freshly cut. It is hard but not very durable.

9.3.42 **Ebony, Karimara, Balemara** – It grows on attaining a girth up 4.5 meters on well drained soils and found chiefly in company with other species "Diospyros" but the heartwood is more than 1.5 meters in girth. One of the reserved trees of Mysore. The wood is very hard and durable, jet black, close and even grained. The wood produces the true ebony of commerce being the only tree of this order that has an absolutely black heartwood.

9.3.43 **Kadjuka, Jiraka** – The wood is dark greyish-brown very hard and close-grained.

9.3.44 **Bilvara** – This is known as the raiyats' tree and the wood is useful for nearly every purpose in his domestic economy. The pods are smaller, thinner and darker. The wood is dark in color than those of Bage brown, shining with paler streaks, straight grained, even smooth and long fibred. It is harder than Siris and seasons and works well and takes fine polish and is fairingly durable. It is liable to split if not carefully and slowly seasoned.

9.3.45 **Padri, Kaladri** – The tree attains a height of 10 to 15 meters and a girth 1.5 to 2 meters and more. The wood is greyish brown with patches of brighter brown coarse and hard. It has no heartwood. It is scented and moderately durable, strong and elastic. It stands well under water.

9.3.46 **Sampige Mara** – This is a fragrant flower tree. The wood is olive-brown in colour beautifully mottled. It is light, soft, close and grained, very durable especially underground and contains a bitter ingredient which prevents rot. It seasons well and takes a fine polish.

9.3.47 **Dindiga** – It grows 1 to 1.5 meters in girth with a clean bole of 9 meters and more. The bark is pale-brown or white-grey and smooth with shallow depressions of account of its peeling off in small flakes. The wood in older trees is yellowish-grey, hard, shining, coarse with a very hard dark, purple centre of small size and irregular shape. It is strong, tough, and elastic and difficult to saw in green state. It is fairly durable under cover, though somewhat liable to split in seasoning.

9.3.48 **Kanagalu Mara** – The wood is reddish-grey in colour. It is rough and moderately hard, heavy strong and durable, even when buried underground. It is apt to split, warp, and crack.

9.3.49 **Massimara** – The wood is greyish brown or olivered grey, moderately hard, shining, close and even grained, seasons well, durable and is not attacked by while ants,

9.3.50 **Godda** – The tree generally attains a girth of 2 meters and even a little more and is capable of yielding good sized logs. The wood is like that of Boswellia (Maddi) when grown into a big tree. It gives a handsome reddish brown heartwood of good quality, even grained and smooth. It seasons well.

9.3.51 **Hadaga** – The tree does not attain much grith. The wood is light brown in colour beautifully mottled with darker veins, even grained and very hard. It is durable and stronger than teak.

9.3.52 **Tare Mara** – The wood is yellowish grey, straight grained, rather coarse and hard with no heartwood. It is not durable as it is readily attacked by insects.

9.3.53 **Myrabolam Tree or Alale** – The wood is brownish grey with a greenish or yellowish tinge, close grained and fairly durable. The timber is cross grained and difficult to work, but takes a good polish.

9.3.54 **Genasu** – The tree is generally crooked and is not capable of attaining more than 1.5 meters in girth. However lengths of 3 to 4 meters can be secured. The wood is very hard, reddish brown and resembles teak. It is smooth, straight grained and even. The wood is tough, elastic and takes a good polish.

9.3.55 **Camboge Tree Guragi, Arsina-Guragi Kankutaka** – The wood is yellow, hard, mottled with numerous wavy concentric bends of soft texture.

9.3.56 **Jagalaganti** – The stem of this tree is generally fluted or furrowed. The wood is grey, dirty white when cut, turning yellow or brown on exposure and streaked with patches of darker colour, especially towards the centre, but there is no regular ebony heartwood. It is fine grained and durable. It is moderately hard and difficult to cut with the axe.

9.3.57 **Noviladi or Bharanige** – Bark is yellowish grey or greyish brown and rough. The wood is grey with a tinge of olive brown, hard, smooth and close grained and polishes well; but it is liable to split and warp. It is durable under water. Much esteemed in Ceylon.

9.3.58 **Chittagong wood or Kalgarige** – The wood is reddish-brown and hard with a fine silver grain and beautiful satiny lusture, seasons and works well. It is most elegantly veined and at the same time very close in the grain. Sapwood is pale and of lighter colour. The fibres run in somewhat different directions and is consequently difficult to plane.
The bark is a powerful astringent and the flowers give a red or yellow dye.

9.3.59 **Vate Mara** – The heart wood is yellow in colour and changes to dull brown on exposure. It is smooth, even grained, fairly hard and durable. It works easily and presents a fair appearance when polished. It gives out an unpleasant odour while being sawn, probably due to the resinous nature of the wood. It resists the attack of white ants.

9.3.60 **Jalari Mara** – The wood is yellow or yellowish brown or grey, hard, smooth and even grained with small dark coloured irregularly shaped heartwood. The wood seasons well and is not attacked by white ants on account of its resinous nature.

9.3.61 **Kavalu or Gavalada Mara** – The wood is dark reddish brown, even grained and durable. It is fairly hard and strong but not very heavy. It is a fine wood, cuts to a smooth surface and takes a good polish. It is difficult to season. It stands well under water.

9.3.62 **Rampatre or Ramanadike** – It is light reddish brown, moderately hard with prominent regular concentric lines.

9.3.63 **Aine tree or Hebbahalasu** – The wood is yellowish-brown in colour. It is moderately hard and straight grained durable, seasons and polishes well. It does not warp or crack nor is eaten by white ants. It stands contact with water well. This is one of the reserved trees of Karnataka.

9.3.64 **Bende Mara** – The wood is white grey and soft. The bark yields a fibre for rope making, for temporary raft tying. It becomes brittle and rots if allowed to dry.

9.3.65 **Hale or Beppale** – The tree is much fluted and grows badly. It is capable of yielding pieces suitable for turning and carving work. The wood is white, moderately hard and even grained. Pores very scanty and very small.

9.3.66 **Kaidhupa or Koidhupa** – The wood in pinkish white when freshly cut, turning grey on exposure. It is straight grained and moderately hard and not durable. The tree yields a large quantity of black resign which is an important article of trade in Mangalore and Udupi districts.

9.3.67 **Kasarike or Casuarina** – The wood is yellowish-pink to redish brown in colour with a long fibre. It is very hard and not easy to work. Sometimes the fibre becomes twisted. It cracks and splits if the timber is not seasoned slowly. It is not durable when exposed but fairly so under cover. It bears great strain and is well adapted for posts.

9.3.68 **Dodda Thoppe or Doddi** – The tree attains a girth of 2 to 2.5 meters with a bole of 8 to 10 meters. The wood is white when cut up fresh and brownish grey if cut up dry. It is soft, but of good quality for purposes for which soft wood is useful.

9.3.69 **Bili Halasu or Sattale** – The tree attains a good size with a clean bole of 15 to 20 meters and even more. The wood is reddish grey, moderately hard and close grained. It seasons well and works to a smooth surface. It is durable if smoked.

9.3.70 **Incence Tree, Maddi, Guggala Dhupa, or Sambrani Dhupa** – Trees growing up to 1.5 to 2 meters in girth are common. The bark is yellow or greenish yellow, exfoliating in small, hard and irregular flakes or thin plates. The heartwood is very small and when present it is handsome, streaked in darker and lighter bands. The wood is moderately hard, smooth and brown in colour. It is not durable, and to some extent free from attacks of white ants.

9.3.71 **Maddale or Madhalle** – The tree attains gignatic girth sometimes and also a height of 30 meters and even more. The wood is white soft and even grained, but seasons badly and soon gets mouldy and discoloured, if allowed to season in logs. The wood is not durable, but is easily workable.

9.3.72 **Ramanadike** – The trees does not grow more than 2 meters in girth, but a height of 15 to 20 meters is common. The wood is light reddish brown, streaked, soft. With many prominent brown concentric lines. The wood is handsome.

9.3.73 **Nirangi** – The wood is red or bark brown in colour, soft, porous and even grained. The tree does not attain more than 1.5 meters in girth even in favourable places.

9.3.74 **Gulmavu** – The wood is orange brown and moderately hard. The timber seasons well, and does not split and cracks.

9.3.75 **Bevu or Margosa Tree** – The wood is dull red in colour. It is fairly hard, close grained and slightly scented. It is durable, mottled and heavy and takes good polish. It is so bitter that no insects attack it. The wood is very much like Mahogany beautifully mottled and heavy.

9.4 General woodwork – wrought & put up

9.4.1 "Carpenter's work" includes all timber in roofs, floors, verandahs, staircases, door and window frames, bridges, centerings, cofferdams, curbs of well, shores, struts, large gates, and generally all wood-work except in the case of battens used in roofing trellis-works, etc., which is not specially moulded or carved.

9.4.2 When the thickness of carpenter's work does not exceed 50 mm and at the same time the width exceeds twice the thickness, it is called "planking".

9.4.3 "Joiner's work " includes furniture, doors and windows, and turned, carved, or moulded work of all kinds.

9.4.4 Carpenter's work is rated per cubic meter, except planking, which is rated by the square metre of a specified thickness, or per Rmtr with specified breadth and thickness and batten work which is rated by the square meter. Doors, windows and similar work, and panelled work generally, are rated per square meter; other joiner's work at special rates, according to the nature of each case.

9.4.5 The timber is to be of the best quality, well seasoned, felled not less than two years before use for carpentry and four years for joinery and free from large or loose knots and from shakes or defects of any kind. Sapwood will be rejected unless it is thoroughly impregnated with creosote or some other approved preservative. Any timber so rejected shall be removed at once from the site of the works, and not again brought thereon unless with the express written permission of the engineer.

9.4.6 The engineer may inspect all logs previous to use, and reject any which he considers defective. The engineer shall however have power of rejecting at any stage, any work which may be found defective in quality or workmanship and shall not be debarred from rejecting wrought timber by reason of his having previously passed the same in the log or in unworked stage.

9.4.7 Carpenter's work is ordinarily specified as "wrought" or "wrought and put up," or "wrought, framed and fixed".

9.4.8 The rate for wrought timber includes carriage to, and delivery at, the site of the works, the fair rendering of all surfaces, chamfering of angles, etc.

9.4.9 The rate of timber "wrought and put up" includes all that is specified in the preceding paragraph, and in addition, all work required for fixing the timber in its proper position in a building, bridge centering, or other construction. The rate includes all special scaffolding, labour, materials, and apparatus for lifting and fixing in position according to the drawing or other instructions furnished by the engineer.

9.4.10 The rate for framed wood-work to include all sawing, jointing framing, labour and materials for raising and fixing, and also, the fitting, fixing and supply, of all straps, bolts, nails, trenails, spikes, screws, etc., necessary for the framing and fixing.

9.4.11 All workmanship is to be of the best description and all joints must fit accurately without wedging or filling. After the wood-work has been erected, any undue shrinkage or bad workmanship is discovered, the contractor shall forthwith amend the same, without any extra charge.

9.4.12 Planking is to be specified with straight square edges, or rebated, ploughed, tongued, or dowelled as may be directed.

9.4.13 All carpenter's work shall be paid by net measurement, no allowance being made for wastage or for dimensions supplied beyond those specified, but the length of each piece shall be taken over all, so as to include projections for tenons or scarfs.

9.4.14 The contractor shall give due notice to the engineer when any timber is to be covered up in the ground, or in the walls of a building, or otherwise ; failing which it shall be optional with the engineer to order it to be uncovered at the contractor's expense, or to measure and pay for only so much as is uncovered.

9.4.15 No timber work shall be painted, tarred, or oiled without the previous written permission of the engineer.

9.4.16 The engineer may order any truss or other framed work to be put together on the ground, and submitted to suitable tests before being placed in position.

9.4.17 When unwrought timber is supplied by a contractor, the rate paid will in all cases include carriage to, and delivery at, the place where it is required for use.

9.4.18 Timber in the log, or wholly or partially wrought, may be supplied to the contractor from government stores or from a dismantled building. In such case the value of the timber so supplied, at the rate payable to the contractor for similar material, will be deducted from the price of the finished work. Where the contract schedule contains no rate for similar material, the value to be deducted will form the subject of special agreement.

9.4.19 A separate rate will be required when material thus supplied has to be framed, re-fitted or reworked in any manner.

9.4.20 When material is supplied to be contractor under either of the two preceding paragraphs, he shall be charged for its full dimensions, no allowance being made for wastage in working or altering it and all of such material not used and charged for as finished work shall be the contractor's property, but the contractor shall

be entitled if required and permitted to utilise such material, as is in his opinion, unsuited to the purpose intended, in consequence of excessive wastage or other cause.

9.4.21 The conditions detailed above will apply to joiner's as well as to carpenter's work, except where they are plainly inapplicable.

9.4.22 All timber-resting on or bedded in masonry must be well coated with boiling coal tar.

9.4.23 The ends of all timbers set in masonry shall have as air space left on end and sides to allow of free circulation of air round it.

9.4.24 Glue shall not be used in joints which are exposed to the weather, and in such exposed work any hard stopping shall be done with tight driven plugs.

9.4.25 No wood-work of any sort shall be set within 0.5 metres of a fireplace or flue.

9.4.26 The contractor will be responsible for the easing or otherwise of all doors, etc., and the closing of all joints which may occur within six months of the completion of the work and which, in the opinion of the engineer, should be attended to.

9.5 Defects in timber for structural and carpenter's work

9.5.1 Prohibited defects - Timber for structural shall not have loose grains, splits, compression wood in coniferous structural timber, heartwood rot, saprot, and warp, wormhole made by powder pest beetles and pitch pockets. Knots, shakes and checks shall not be permitted in regions of maximum stress intensities nor shall they be permitted at locations where joints are to be provided.

9.5.2 Permissible defects

The following defects are permissible

a) Wanes provided they are not combined with knots and reduction in strength on account of the wanes is not more than the reduction with the maximum allowable knots.

b) Worm holes, other than those due to powder pest beetles, located and grouped that reduce the strength of timber shall be evaluated in the same way as knots.

c) Sap wood not more than 15 per cent of the area of the section may be allowed provided it is properly treated with preservative as specified in IS 401-1982, Code of practice for preservation of timber.

d) All other defects which do not affect any of the mechanical properties.

e) Location and permissible limit of the size of knots, depth of checks and shakes and slope of grain shall be as applicable for Grade I structural timber as per IS 3629-1986. Details furnished in Annexure 9-A.1.

9.5.3 Defects in timber for joiner's work

9.5.3.1 Prohibited defects - Timber for joiner's work shall be free from decay, fungal growth, boxed heart, pitch pocket or streaks on the exposed edges, boxer holes, splits, cracks, pin holes and worm holes.

9.5.3.2 Permissible defects

a) Cross grain shall not be steeper than 1 in 15.

b) The diameter of individual sound knot and live knot shall not exceed 25 mm and the aggregate area of the knots shall not exceed one percent of the area of the piece.

c) Timber shall be generally free from sapwood, but traces of sapwood up to 15 percent may be allowed provided it is properly treated with preservative as specified in IS 401-1982, Code of Practice for preservation of timber.

9.6 Seasoning of timber - The process of drying timber under controlled conditions is called seasoning of timber. Timber shall be either air seasoned or kiln – seasoned and in both cases moisture content of a seasoned timber shall be as specified in Table of section 9. Unless otherwise specified, air seasoned timber shall be used. Kiln seasoning of timber, where specified, shall be done as per IS 1141 - 1993 in a plant approved by engineer.

9.7 Tolerances - Seasoned timber (whether air or kiln dried) shall be deemed to conform to the moisture content requirements if the average moisture content of all samples from a given lot is within + 3 per cent and the moisture content of individual sample is within + 5 per cent of the maximum permissible moisture content for the particular end use and locality as indicated above.

9.8 Moisture content - Moisture meters obviate the necessary of cutting test samples and yield immediate results and are particularly suited for checking of moisture of timber in the field. This method is however not as precise and fool-proof as oven drying method. The accuracy of determination under field conditions of use after observing necessary precautions and applying the appropriate corrections to take account of timber species is not better than ± 2 per cent of the results obtained by oven drying method. Any dispute concerning the moisture content of timber shall be decided by recourse to the oven drying method as described in IS 287-1973.

Table 1 Maximum permissible moisture content of timber

Sl.No.	Use	Max moisture content percent			
		Zone I	Zone II	Zone III	Zone IV
1.	Beams, Rafters and Posts	12	14	17	20
2.	Doors and Windows				
	a) 50 mm and above thickness	10	12	14	16
	b) Thinner than 50 mm	8	10	12	14
3.	Flooring strips	8	10	10	12
4.	Furniture and Cabinet making	10	12	14	15

9.9 Preservation of timber - Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers, and marine organisms, Preservative treatment, where specified, shall be done using oil type, organic solvent type or water –soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned. All surfaces exposed after treatment, except due to planning, shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401 - 1987 in a plant approved by the engineer.

9.10 General guidelines for good workmanship - All wood work and carpenter's work shall be carried out as detailed in drawings or as directed by the engineer.

9.10.1 Species of timber - Only the specified species of timber shall be used. For any one structural unit, only one species of timber shall be used.

9.10.2 Sawing and planing - Sawing shall be truly straight and square and in the direction of grains except for the members which are curved. Where indicated, the members shall be planed smooth to the full dimensions are rebated, rounded, chamfered or moulded as detailed in the drawings or directed, before they are fixed or framed and fixed. A tolerance of – 2 mm and + 3 mm shall be allowed in the finished cross sectional dimensions.

9.10.3 Nails - Steel wire nails shall conform to IS 723-1972, Specification for steel countersunk head wire nails. The nails shall be machine made. The head should be properly formed, chequered and concentric with the shank. The ends shall be sharp and pointed. Nails shall be plain finished.

9.10.4 Wood screws - Steel wood screws shall conform to IS 451-1972. Technical supply condition for wood screws and of the type, finish and size as required or as directed. Screws shall be cleanly finished and the heads shall be true and concentric with the shank. Slots in the head shall be clear, straight and free from burrs and central with regard to the head. Threads shall be clear and well defined. Wood screws shall be in 'self colour' condition.

9.10.5 Glue - Adhesives and glues for putting together in wood work and joinery shall conform to

a) synthetic adhesives WRB or MR grade conforming to IS 851-1978, Synthetic resin adhesives for construction work in wood ; or
b) synthetic adhesives conforming to IS 4835-1979, Polyvinyl acetate dispersion based adhesives for wood ;

9.10.6 Jointing - The contractor shall observe the following principles in forming joints

a) To form joints and arrange the fastenings in such a way so as to weaken as little as possible the pieces of timber they connect.

b) To place each abutting surface in a joint, as nearly as possible, perpendicular to the pressure it has to transmit ;

c) To form and fit accurately every pair of surfaces that come in contact.

9.10.7 Joints - Joints in timber frames shall be made carefully and securely. Notches shall in no case remove more than the quarter of the section. All mortice and tenon, mitred, scarf and other joints shall fit fully and truly without wedging or bamboo pins of about 10 mm dia.

9.10.8 Fabrication - Fabrication shall be done in the best possible manner and all necessary mild steel ties, straps, bolts, etc., shall be fitted as indicated. Members shall be fabricated accurately so that these can be assembled without being unduly packed, strained or forced into position and when build up shall be true to shape and free from twist, kinks, buckle or open joints. Patching or plugging of any kind shall not be allowed.

9.33 SPECIFICATIONS FOR DOOR, WINDOW AND VENTILATOR FRAMES

9.33.1 Timber for door, window and ventilators frames shall be as specified. Timber 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 warp or blow. Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. 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. A tolerance of +/- 3 mm and 2 mm shall be permitted in the specified finished dimensions of timber sections in frames.

9.33.2 Joints - The frames shall have dovetail joints Fig. 1. 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. 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 the WBP or MR grade of IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. 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.

9.33.3 Fixing of frames - The frames shall be got inspected approved by the engineer before being pinned, oiled or otherwise treated and before fixing in position. 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. Frames shall be fixed to the abutting masonry or concrete with hold fasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be warping during construction. 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. 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.

9.33.4 Measurements - Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension without any allowance for the wastage or for dimension beyond specified dimensions. However, in case of members having mouldings, roundings 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. 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 10 cubic decimetre in whole numbers.

9.33.5 Rate - The rate shall include the cost of material and labour involved in all the operational described above except the hold fasts or metallic fasteners which will be paid for separately.

9.34 SPECIFICATIONS FOR PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS

9.34.1 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, fibre board wire gauze or sheet glass. The shutters, single or multipanelled, as shown in the drawings or as directed by the engineer. 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. 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.

9.34.2 Frame work - 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 haunched 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.

9.34.3 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 aminoplastic) 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.

Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be out 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.

Table 7 Dimensions of components of frame work

Sl.No.	Description	Width mm	Thickness mm	
A. Door shutters				
a.	Stile, top and free rail	100	35 or	40
b.	Lock rail	150	35 or	40
c.	Bottom rail	200	35 or	40
d.	Muntin	100	35 or	40
e.	Glazing bar	40	35 or	40
B. Window, ventilator & cupboard shutters				
a.	Stile, top and freeze rail	80	20, 25 or	30
b.	Bottom rail	80	20, 25 or	30
c.	Muntin	60	20, 25 or	30
d.	Glazing bar	40	20, 25 or	30

Muntin 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 works of shutters shall be as given in Table 7. Tolerance on widths of stiles and rails shall be +/- 3 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.

9.34.4 Rebating - The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the engineer. 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 sprayed or square type as shown in Fig. 2.

9.34.5 Panelling - The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, hard board and particle board panels 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. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving on space of 1.5 mm. Width and depth of the rebate shall be equal to half of 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.

9.34.6 Timber panels - Timber panels shall be preferably made of timber of large width ; the minimum width and thickness of the panel shall be 150 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 metre 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.

9.34.7 Plywood panels - Plywood panels used for panelling of shutters shall be BWP type or grade as specified in 9.2.8. Each panels shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm for single panel construction unless otherwise specified.

9.34.8 Block board panels - Block Board used for panelling of shutters shall be Grade 1 (Exterior Grade) bonded with BWP Type Synthetic resin adhesives as specified. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

9.34.9 Veneered particle board panels - Veneered Particle board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

9.34.10 Fibre board panels - Fibre board used for panelling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified. Each fibre board panel shall be a single piece of thickness 10 mm unless otherwise specified.

9.34.11 Wire gauze panels - Wire Gauze used for panelling of shutters shall be woven with 0.63 mm dia galvanised mild steel wire to form average aperture size of 1.40 mm as specified. 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 shall 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 as 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 gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading on the external face in the required patterns as decided by the engineer.

SECTION 15

FINISHING WORK

15.5 SPECIFICATIONS FOR CEMENT PLASTERING

15.5.0 The cement plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

15.5.1 Scaffolding and preparation of surface shall be as specified in 15.1

15.5.2 Mortar - The mortar of the specified mix using the type of sand described in the item shall be used. It shall be as specified. For external work and under coat work, the fine aggregate shall conform to grading IV. For finishing cost work the fine aggregate conforming to grading zone V shall be used.

15.5.3 Application - The specifications as in 15.1.4 shall apply except in the following respects -

a) Beating with thin bamboo strips shall not be done on the cement plaster, and

b) No lime putty solution shall be applied on the face when finishing. Further the plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

15.5.4 Thickness - Where the thickness required as per description of the item is 20 mm the average thickness of the plaster 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 15 mm while in case of stone work the minimum thickness over the bushings shall be not less than 12 mm.

15.5.5 Curing - Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

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 may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

Specifications for Finish, Precautions, Measurements and Rate shall be as described in 15.1

15.6 SPECIFICATIONS FOR CEMENT PLASTER WITH A FLOATING COAT OF NEAT CEMENT

15.6.0 The cement plaster shall be 12, 15 or 20 mm thick, finished with a floating coat of neat cement, as described in the item.

15.6.1 Specifications for this item of work shall be same as described 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 (clause 13.5.3) 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 per 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 as described in 15.5.3 shall apply.

15.7 SPECIFICATIONS FOR 18 MM CEMENT PLASTER (TWO COAT WORK)

15.7.1 The specification for scaffolding and preparation of surface shall be as described in 15.5

15.7.2 Mortar - The mix and type of fine aggregate specified in the description of the item shall be used for the respective coats. It shall be as specified in section 0.5. Generally the mix of the finishing coat shall not be richer than the under c**oat 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. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

15.7.3 Application

15.7.3.1 The plaster shall be applied 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.

12 mm Under Coat

15.7.3.2 This shall be applied as specified except that when the plaster has been brought to a true surface a wooden straight edge and 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 is applied.

]6 mm finishing coat

15.7.3.3 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 as specified.

15.7.4 Specifications for Curing, Finishing, Precautions, Measurements and Rate shall be as described in 15.5

15.8 SPECIFICATIONS FOR 6 MM CEMENT PLASTER ON CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK

15.8.0 Scaffolding - Stage scaffolding shall be provided for the work. This shall be independent of the walls.

15.8.1 Preparation of Surface - Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surface to be plastered shall be pock marked with a pointed tool, at spacings of not more than 5 cm. Centres, 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 of all oil, grease etc. and well wetted before the plaster is applied.

15.8.2 Mortars - Mortar of the specified mix using the types of sand described in the item shall be used. It shall be as specified.

15.8.3 Application -To ensure even thickness and a true surface, gauges of plaster 15 x 15 cm, shall be first applied at not more than 1.5 m intervals in both 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 troweling 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.

15.8.4 Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In 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.

15.8.5 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.

15.8.6 Thickness - 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.

15.8.7 Curing - The specifications shall be as detailed in 15.5

15.8.8 Precautions - These shall be as described in 15.1.8.

15.8.9 Measurements

15.8.9.1 Length and breadth shall be measured correct to a cm. and its area shall be calculated in sqm. correct to two places of decimal. Dimensions before plastering shall be taken.

15.8.9.2 Thickness of plaster shall be exclusive of the thickness of the key i.e., depth or rock marks and hacking.

15.8.9.3 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.

15.8.9.4 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 as measured under 15.8.9.3.

15.8.9.5 Plastering on spherical and groined ceiling and circular work not exceeding 6 m in radius, shall be measured and paid for separately.

15.8.9.6 Flowing soffits (Viz. portion under spiral stair case etc.) shall be measured and paid for separately.

15.8.9.7 Ribs and mouldings 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.

15.8.9.8 The mode of measurement of exterior plaster and patch plastering (in repairs) shall be as laid down in 15.1.9.8

15.8.9.9 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.

15.8.10 Rate - The rate shall include the cost of all labour and materials involved in all the operations described above.

15.22 SPECIFICATIONS FOR CEMENT WATER PROOFING COMPOUND

It shall be used for cement mortar for plastering or concrete work.

15.22.1 Water proofing compound - Integral cement water proofing compound conforming to IS : 2645-1975 and of approved brand and manufacture, enlisted by the Engineer from time to time shall be used.

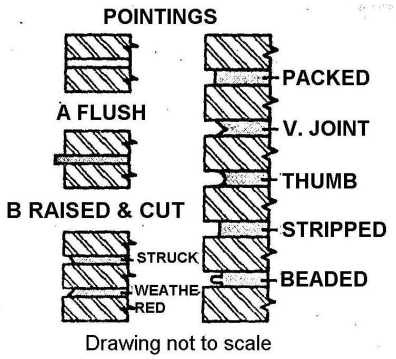
15.22.2 The contractor shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in 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.

15.22.3 It shall be measured by weight.

15.22.4 The rate shall include the cost of all labour and materials involved in all the operations described above.

15.24 SPECIFICATIONS FOR POINTING ON BRICK WORK, TILE WORK AND STONE WORK

15.24.0 Pointing shall be of the type shown in figure below



Drawing not to scale

15.24.1 Scaffolding - For all exposed brick work or tile work, independent 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.

All other brick work in building, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole and 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 metre 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 advance.

15.24.2 Preparation of surface -The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

The joints shall be raked to such a depth that the minimum depth of a new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12 mm.

15.24.3 Mortar - Mortar of specified mix shall be used. It shall be as specified.

15.24.4 Application and finishing

15.24.4.1 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 -

15.24.4.2 Flush Pointing - The mortar shall be pressed into the 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.

15.24.4.3 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.

15.24.4.4 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 functions of vertical joints with the horizontal joints shall be at true right angles.

15.24.4.5 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 sand about 6 mm raised and width 10 mm more as directed.

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.

15.24.5 Curing - The pointing shall be kept wet for seven days. During this period it shall be suitably protected from all damages.

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.

15.24.6 Measurements

15.24.6.1 Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres up to two places of decimal.

15.24.6.2 The various types of pointing for example, struck, keyed, flush, truck, etc. shall each be measured separately.

15.24.6.3 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.

15.24.6.4 Pointing in a single detached joint as for flashing shall be given in running metres.

15.24.6.5 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, in case of pointing on external face only.

a) No deductions shall be made for ends of joists beams, posts etc. and openings not exceeding 0.5 sqm each, and no addition shall be made for reveals, jambs, soffits, sills, 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 pointings 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 are 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.

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.

a) Raking out joints for old work only shall be measured and given in square metres.

b) Raking out joints of old work built in mud mortar, lime mortar and cement mortar shall each be measured separately.

c) Raking out joints of different types of old walls, floors etc. shall each be measured separately.

d) Raking single detached joints as for flashing old work shall be given in running metres.

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

15.25 SPECIFICATIONS FOR WHITE WASHING WITH LIME

15.25.1 Scaffolding

15.25.1.1 Wherever scaffolding is necessary, 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 or touch the surface which is being white washed.

15.25.1.2 For all exposed brick work or tile work 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.

Note

In case of special type of brick work, scaffolding shall be got approved from Engineer in advance.

15.25.1.3 Where ladders are used, pieces of all gunny bags shall be tied on their tops to avoid damage or scratches to walls.

15.25.1.4 For white washing the ceiling, proper scaffolding shall be erected.

15.25.2 Preparation of surface - **Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings an foreign matter.**

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 cm area shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer, the entire surface of old white wash shall be thoroughly removed by scrapping 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.

15.25.3 Preparation of lime wash

15.25.3.1 The lime wash shall be prepared from fresh stone white lime. 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 10 cubic decimeter of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg of lime.

Indigo (Neel) up to 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 litres per kg. of lime to produce a milky solution.

15.25.4 Application

15.25.4.1 The white wash shall be applied with moonj brushes to the specified 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.

15.25.4.2 Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

15.25.4.3 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. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

15.25.4.4 For old work, after the surface has been prepared as described, 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 stipulated in the description of the item 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.

15.25.5 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.

15.25.6 Measurements

15.25.6.1 Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

15.25.6.2 Measurements for jambs, Soffits, and Fills etc. for openings shall be as described.

15.25.6.3 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.

Corrugated asbestos cement sheet	-	20%
Semi corrugated asbestos cement sheet	-	10%

15.25.6.4 Cornices and other such wall or ceiling features, shall be measured along the girth and included in the measurements.

15.25.6.5 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.

15.25.6.6 Work on old treated surfaces shall be measured separately and so described.

15.26 SPECIFICATIONS FOR LIME WASHING - Lime wash shall be used as a base coat where so specified. The specifications for 'white washing with lime' shall apply except that quality lime shall be used and the wash will be mixed to a thicker consistency. The other details and specifications described in 15.25 will apply in toto**.**

15.27 SPECIFICATIONS FOR WHITE WASHING WITH WHITING

15.27.1 Preparation of Mix - Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. Two kg of gum and 0.4 kg of copper sulphate 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 use.

15.27.2 Other specifications described shall apply in this case also.

15.28 SPECIFICATIONS FOR COLOUR WASHING

15.28.1 The mineral colours, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the engineer. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.

For 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.

For old work, after the surface has been prepared as described 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. The colour washed surface shall present 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 15.25

15.29 SPECIFICATIONS FOR DRY DISTEMPERING

15.29.1 Materials - Dry distemper of required colour (IS - 427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using

6 decilitres (0.6 litre) 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.

15.29.2 Preparation of Surface

15.29.2.1 Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

15.29.2.2 New plastered surfaces shall be allowed to dry for at least two months, before applying distemper.

15.29.2.3 In the case of old work, all those pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

15.29.2.4 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.

15.29.3 Priming Coat - A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface be allowed to dry before distemper coat is given.

15.29.4 Application

15.29.4.1 In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface attains an even colour.

15.29.4.2 For old work, the surface prepared as described shall be applied one or more coats of distemper till the surface attains an even colour.

15.29.4.3 The application of each coat shall be as follows - 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.

15.29.4.4 The subsequent coats shall be applied only after the previous coat has dried.

15.29.4.5 The finished surface shall be even and uniform and shall show no brush marks.

15.29.4.6 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.

15.29.4.7 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.

15.29.5 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described.

15.30 SPECIFICATIONS FOR OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING

15.30.1 Materials - Oil emulsion (Oil Bound) washable distemper (IS -428) of approved brand and manufacture shall be used. The primer 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 tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer.

15.30.2 Preparation of the Surface

15.30.2.1 For 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 pairs mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

15.30.2.2 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.

15.30.3 Application

15.30.3.1 Priming Coat - The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described.

Note

If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended 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 coat conforming to IS - 109 and allowed to dry for at least 48 hours before distempering is commenced.

For old work no primer coat is necessary.

15.30.3.2 Distemper Coat - For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly 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 constitutes 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 of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For 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 caked with distemper shall not be used on the work.

15.30.4 The specifications in respect of scaffolding, protective measures and measurements shall be as described.

15.30.5 Rate - The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

15.31 SPECIFICATIONS FOR CEMENT PRIMER COAT

15.31.0 Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on asbestos cement surfaces before oil emulsion distemper paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalis present in the cement, lime or lime 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 cement primer before applying oil emulsion paints etc.

15.31.1 Preparation of the surface : 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.

15.31.2 Application : The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal 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. It shall be allowed to dry for at least 48 hours, before oil emulsion paint is applied.

The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 15.25

15.32 SPECIFICATIONS FOR CEMENT PAINT

15.32.1 Material -The cement paint shall be (conforming to IS : 5410) of approved brand and manufacture.

The cement paint shall be brought to the site of work by the contractor in its original containers is 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 materials shall be kept in the joint custody of the contractor and the engineer. The empties shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the engineer.

15.32.2 Preparation of surface - For 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**.**

15.32.3 Preparation of mix - Cement paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement paint of 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 meticulously.

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.

15.32.4 Application

15.32.4.1 The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It 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

method of application of cement paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work.

15.32.4.2 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.

15.32.4.3 For 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.

15.32.4.4 For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

15.32.5 Precaution - Water proof cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsums, would and metal surfaces.

15.32.6 The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described in 15.25. The coefficient for cement paint on RCC jalli shall be the same as provided in Sl. No. 7 of Table 1 under para 15.33.6.4 for painting trellis work.

15.33 SPECIFICATIONS FOR PAINTING

15.33.1 Materials - Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint the brand of thinner recommended by the manufacturer or as instructed by the Engineer shall be used.

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 adequate quantities to suffice 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. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the engineer.

15.33.2 Commencing Work - Painting shall not be started until the engineer has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the paint work being started.

15.33.3 Preparation of Surface - The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall the thoroughly removed before

painting is started. The prepared surface shall have received the approval of the engineer after inspection, before painting is commenced.

15.33.4 Application

15.33.4.1 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.

15.33.4.2 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 the 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.

15.33.4.3 Where so stipulated, the painting shall be done by spraying. Spray machine used be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed to the requisite consistency by adding a suitable thinner.

15.33.4.4 Spraying should be done only when dry condition prevails. 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 one 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.

15.33.4.5 No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

15.33.4.6 No hair marks from the brush or clogging of paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

15.33.4.7 In painting doors and windows, the putty round the glass panes 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 nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

15.33.4.8 On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

14.33.4.9 The additional specifications for primer and other coats of paints shall be as according to the detailed specifications under the respective headings.

15.33.5 Brushes and containers - After work, the brushes shall be completely cleaned of paint and linseed oil by rinsing with turpentine. 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. When the paint has

been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

15.33.6 Measurements

15.33.6.1 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.

15.33.6.2 Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

15.33.6.3 Painting up to 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres and shall include cutting to line where so required.

15.34 SPECIFICATIONS FOR PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

15.34.1 Primer

15.34.1.1 The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

15.34.1.2 Primer for plaster / wood work/ Iron & Steel / Aluminium surfaces shall be as specified below :

Table 2

S. No.	Surfaces	Primer to be used
1	Wood work (hard and soft wood)	Pink conforming to IS : 3536
2	Resinour wood and plywood	Aluminium primer conforming to IS : 3585
3	(A) Aluminium and light alloys	Zinc chromate primer conforming to IS : 104
	(B) Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer conforming IS : 2074
4	Cement /Conc/RCC/brick work, Plastered surfaces, asbestos surfaces to receive Oil bound distemper or paint finish	Cement primer conforming to IS : 109

15.34.1.3 The primer shall be ready mixed primer of approved brand and manufacture.

15.34.1.4 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 litre.

15.34.1.5 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 litre : 1 litre.

15.34.1.6 The specifications for the base vehicle and thinner for mixed on site primer shall be as follows :

a) White lead - The White lead shall be pure and free from adulterants like barium sulphate and whiting. It shall conform to IS : 103-1962

b) Red lead - This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall conform to IS : 102-1962

c) Raw linseed oil - 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.

Note - The oil shall be mellow and sweet to the taste with very little smell. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall conform in all respects to IS : 75-1973 The oil shall be of approved brand and manufacture.

d) Double boiled linseed oil : This shall be more viscous than the raw oil, have a deeper colour and specific and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall confirm in all respects to IS : 77-1976 The oil shall be of approved brand and manufacture.

e) Turpentine : Mineral turpentine i.e., petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleeresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall conform to IS : 533-1998

15.34.1.7 All the above materials shall be of approved manufacture and brought to site in their original packing in sealed condition.

15.34.2 Preparation of Surface

15.34.2.1 Wooden Surface : The wood work to be printed shall be dry and free from moisture.

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS : 345-1952 with same shade as paint shall be used where specified. The surface treated for knotting shall be dry before paint is applied. After obtaining approval of Engineer 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 respectively. 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.

15.34.2.2 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.

Plastered Surface - The surface shall ordinarily not be painted until it has dried completely. 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.

15.34.2.3 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 15.33.4

15.34.4 SPECIFICATIONS FOR TREATMENT ON STEEL FOR AGGRESSIVE ENVIRONMENT

15.34.4.1 A second coat of ready mixed red oxide zinc chromate primer may be applied where considered necessary in aggressive environment such as near Industrial establishment and coastal regions where the steel members are prone to corrosion. The second coat (which shall be paid for separately) is to be applied after placing the member in position and just before applying paint. The second coat of primer is not necessary in case of painting with synthetic enamel paint as it is applied over an under coat of ordinary paint.

15.34.4.2 The specifications described under 15.33 shall hold good so far as they are applicable.

15.35 SPECIFICATIONS FOR PAINTING WITH READY MIXED PAINT - Ready mixed paints of approved brand and manufacture and of the required shades shall be used. They shall conform in all respects to the relevant IS Specifications.

15.35.1 Painting on new surface - The surface which has not been painted earlier, or the paint had been removed by paint remover, burning, caustic soda etc., shall be considered to be new surface.

15.35.1.1 Preparation of surface

a) Wood work : The surface shall be cleaned and all unevenness removed as specified knots if visible, shall be covered with a preparation of red lead. Holes and indentations on the surface shall be filled in with glazier's putty or wood putty conforming to IS : 419 and rubbed smooth before painting is done. The surface should be thoroughly dry before painting.

b) Iron and steel work : The priming coat shall have dried up completely before painting is started. Rust and scaling shall be carefully removed by scraping or by brushing with steel wire brushes. All dust and dirt shall be carefully and thoroughly wiped away.

c) Plastered surface : The priming coat shall have dried up completely before painting is started. All dust or dirt that has settled on the priming coat shall be thoroughly wiped away before painting is started.

15.35.1.2 Application - The specifications described shall hold good as far as applicable. The number of coats to be applied will be stipulated in the item. The painted surface shall present a uniform appearances and glossy finish, free from streaks, blisters etc.

15.35.1.3 The specifications described in 15.33 shall hold good in so far as they are applicable.

15.35.2 SPECIFICATION FOR PAINTING ON OLD SURFACE - The surface which has been painted earlier shall be considered.

15.35.2.1 Preparation of Surface

a) Wood work - If the old paint is sound and firm and its removal is considered unnecessary, the surface shall be rubbed down with pumice stone after it has been cleaned of all smoke and grease by washing with lime and rinsing with water and drying. All dust and loose paint shall be completely removed. The surface shall then be washed with soap and water.

If the old painted surface is blistered or flaked badly old paint shall be completely removed as described and such removal shall be paid for separately. Holes and cracks if any shall be stopped with glazier's putty or wood putty conforming to IS : 419-1967. Further the painting itself shall be treated as on new surface and paid for, accordingly.

b) Iron and steel work - If the old paint is sound and firm and its removal is considered unnecessary, it shall be rubbed with wire brushes and any loosened paint taken off. All dust shall then be thoroughly wiped away. The surface shall then be wiped finally with mineral turpentine to remove grease and perspiration of hand marks etc. and then allowed to dry.

If the old painted surface is in bad condition and blistered and flaked, the old paint shall be completely removed and the surface prepared, as described. Such removal shall be paid for separately. The painting including the priming coat shall be treated as on nee work and paid for accordingly.

c) Plastered surface - It shall be as specified for wood work. If before painting any portion of the wall shows signs of dampness, the causes shall be investigated and the damp surface shall be properly treated. Such treatment shall be paid for separately. A thin coat of white lead if so required shall be applied on the wet or patchy portion of the surface before painting is undertaken and this shall be paid extra.

15.35.2.2 Application - The specifications as described shall hold good as far as possible. The number of coats to be given shall be as stipulated in the description of the item

The specifications described 15.3.3 shall hold good in so far as they are applicable.

15.42 SPECIFICATIONS FOR WALL PAINTING WITH PLASTIC EMULSION PAINT

15.42.0 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.

15.42.1 Plastic emulsion paint as per IS : 5411 of approved brand and manufacture and of the required shade shall be used.

15.42.2 Painting on new surface - 15.42.2.1 The wall surface shall be prepared as specified in 15.33.3

15.42.2.2 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. If necessary more coats will be applied till the surfaces presents a uniform appearance.

15.42.2.3 Precautions

a) 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.

b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

d) Washing of surfaces treated with emulsion paints shall not be done within 3 or 4 weeks of application.

Other details shall be as specified as far as they are applicable.

15.42.3 Painting on old surface

15.42.3.1 Preparation of surface

This shall be done, generally as specified except that the surface before application of paint shall be flattened well to get the proper flat velvety finish after painting.

15.42.3.2 Application : The number of coats to be applied shall be as in description of item.

The application shall be as specified in 15.42.2.2 except that thinning with water shall not normally be required.

15.42.3.3 Other details shall be as specified in 15.33 as far as applicable.

15.43 SPECIFICATIONS FOR PAINTING WITH ENAMEL PAINT

15.43.1 Enamel paint (conforming to is : 2933) of approved brand and manufacture and of the required colour shall be used.

For the under coat, the paint of same quality but of shade to suit that of the top coat shall be used.

15.43.2 Preparation of surface and application shall be as specified under 15.35 for painting on new surfaces or old surfaces, as the case may be.

15.43.3 Other details shall be as specified in 15.33 as far as applicable.

15.44 SPECIFICATIONS FOR PAINTING WITH SYNTHETIC ENAMEL PAINT

15.44.1 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 shall be used.

15.44.2 Painting on new surface

15.44.2.1 Preparation of surface shall be as specified in 15.35.1.1(a) and (b) as the case may be.

15.44.2.2 Application: The number of coats including the undercoat shall be as stipulated in the item.

a) 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.

b) Top coat : Top coats of synthetic enamel paint of desired 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.

15.44.2.3 Other details shall be as specified in 15.33 as far as they are applicable.

15.44.3 Painting on old surface

15.44.3.1 Preparation of surface - Where 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 dusted off. 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 15.54. Such removal shall be paid for separately and the painting shall be treated as on new surface.

15.44.3.2 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.

15.44.3.3 Other details shall be specified in 15.33 as far as they are applicable.

15.54 SPECIFICATIONS FOR REMOVING OLD PAINT

15.54.1 With patent paint remover

15.54.1.1 Patent paint removers 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. 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.

15.54.1.2 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.

15.54.1.3 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.

15.54.1.4 Preparation of surface - The surface shall then be prepared as described in 15.34.2

15.54.1.5 Measurements - Specification in 15.33.6 shall hold good.

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

15.54.1.7 Other details shall be as specified in 15.33 as far as possible.

15.54.2 With caustic soda solution

15.54.2.1 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 of in the same way as described. 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 to remain are liable to spoil the new paint applied over it. A little acetic acid or vinegar added to the final change of rinsing water helps to neutralize any remaining alkali.

15.54.2.2 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.

15.54.2.3 Preparation of surface, Measurements, Rate and other details shall be as specified in 15.54.1

15.54.3 With blow lamp - The paint shall be removed either with a blow lamp or with an 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.
15.54.3.2 Precautions - Removal with blow lamp shall not be done on narrow or caved under cut surfaces or where there is risk of damage to neighboring materials such as panes in glazed windows.

15.54.3.3 Preparation of surface, Measurements, Rate and other details shall be as described in 15.54.1

Neighbouring painted surfaces which are not to be treated should be properly protected from contact with paint remover.