VOLUME III

GENERAL SPECIFICATIONS – CIVIL WORKS

General Civil Specifications for the works to be carried out form an integral part of these specifications and contractor shall conform to these specifications.

1.0 General :

a. Design of all reinforced concrete structures shall be as per IS:456, of pre-stressed concrete structures as per IS:1343. The structural safety of all foundations on soil shall, in general be based on IS:1904.
b. For calculation purpose "Limit state Design" methods according to IS:456-2000 shall generally be adopted, except for water retaining structures where IS:3370 (PartI-IV) shall be referred and other special cases requiring design by working stress method.
c. All grouting below machine/equipment bases, and pockets shall be non-shrinking grout of adequate thickness and minimum grade of M35 with 6mm and down aggregates. Grouting below structural column bases shall be minimum grade of M30 with 6mm and down aggregates.
d. PCC grade M15 – Apron, plinth protection, screed concrete, foundation below masonry walls, encasing of underground pipes & conduits, ground floor at plinth level, toilet, rest room, etc.
e. All foundations and concrete structures shall be designed to resist full operating dead and live loads, with appropriate combination of wind and seismic forces and with due allowance for impact, inertia loading, vibration, unbalanced dynamic loads, etc. as secondary effect of live loads, erection loads, temperature variation etc. While designing structures and foundations either the effect of seismic forces or wind loads, whichever produces the worst effect, shall be considered along with usual load conditions. Apart from the installation and operating loads indicated by the equipment manufacturers, the design of buildings and structures shall be based on dead and imposed loads calculated according to IS:875. All structures shall be designed for sesimic load as per IS1893 2002/latest in teh catgeogry one above the satted in the specified code.
f. Concentrated and uniformly distributed live load on floors and platforms shall be considered depending upon the usage and in accordance with maximum expected process requirements, to be indicated by the equipment manufactures. When the loads are movable, they shall be so placed as to get worst effect in moment & shear, axial load etc. for which the elements shall be designed. The effect of concentrated load
g. shall not be reduced. Due allowance shall be made, wherever necessary, for installation and operation of any equipment as per equipment manufacturer's data and recommendations. The design shall be based on the maximum loading due to uniform live load and/or equipment loading including impact, vibration, unbalanced operating forces, etc.
h. Foundations for structures and equipment shall be proportioned to resist the worst combination of loading and shall generally be designed as per the provision of IS:1904 for open foundations on soil and IS: 2911 for foundations on piles.

2 DEFINITIONS- EXCAVATION IN ALL TYPES OF SOILS EXCLUDING ROCK

The works under this head shall comprise of the following and shall have the meanings hereby assigned to them:

a) "Excavation" means excavation in open cut (excluding trench excavation outside buildings / structures) down to levels required as per approved drawings or otherwise as being the general levels after completion of excavation.

b) “Trench excavation" means excavation (ouside buildings / structures) of trenches into which pipes (of all types and sizes upto 2000mm) and cables are to be laid to levels and limits as required as per approved drawings or otherwise. This shall also include miscellaneous isolated lengths of trenches beneath or adjacent to other structures.

The term "excavation" is deemed to include for disposing excavated material within 500M in any of the following ways :

Back-filling to excavations and completed structures within the site using suitable excavated material and including placing in temporary spoil tips and any double handling required all as specified hereafter.

Or transporting and placing approved excavated material in permanent spoil tips, including the shaping and drainage of such tips all as specified hereafter.

Or transporting selected excavated material to locations within the site where embankments are to be constructed or where filling around structures is specified to be constructed as embankment including tipping ready for spreading and compacting.

2.1 EXCAVATION

The ground shall be excavated by such methods and to such dimensions and depths as shall allow for the proper construction of the works and safety of personnel and equipment used on excavation. Slopes required for stable formation of sides shall be provided. The excavation shall include excavation in earth and murrum shall be carried out to the correct levels required and specified and no clearance, plus or minus (ie. no overcuts), shall be permitted. However, if any overcuts / depressions are formed due to fault of contractor, they shall be made good by filling with M-7.5 concrete up to the bottom layer of the footing/raft without any extra cost implication. When excavation has reached within 300 mm of the required formation level, further excavation shall be carried out carefully to avoid any overcuts / depressions.

2.2 EXCESS EXCAVATION (EXCLUDING OVERCUTS / DEPRESSIONS AS IN CL. 1.2) TO BE MADE GOOD

In case of excess excavation by the Contractor (beyond that specified in drawings), the contractor shall , at his own expense, if directed , remove from the pits all material resulting from excess excavation and shall make good the same with such kind of fill

material or in such class of concrete as may be reasonably required by Employer's Representative having regard to the circumstances.

The Contractor shall backfill such excess excavation with concrete, rubble, stone or rock fill as directed by the Employer's Representative/ PMC Consultant. Filling other than concrete shall be placed in layers not exceeding 300 mm in thickness, shall be thoroughly compacted and have adequate fines content to fill the voids.

2.3 SUPPORTING EXCAVATIONS

The Contractor shall well and effectually support the sides and ends of all excavations to prevent fall or run from any portion of the ground outside the excavation and to prevent settlement or damage to structures adjacent to the excavation. Any excavation necessary to provide space for such support or other working space shall be carried out. If, for any reason, any portion of the bottoms, sides or ends of any excavations shall give way, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby distributed. Where the Contractor elects and is permitted by the Employer's Representative / PMC Consultant to perform excavations with sloping faces (other than sloping excavations shown on the drawings or required as permanent features of the works) and without shoring, the excavated faces shall be to stable slopes and heights.

2.4 TIMBER SHORING

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'rolling boards'. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal wailings of strong wood at maximum 1.2 metres spacing and suitably strutted. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical wailings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

The shoring material shall not be of sizes less than those specified below unless steel sheet piling is used or unless otherwise approved by the Employer's Representative in writing:

a) Planks - 5 cm x 25 cm
b) Waling pieces - 10 cm x 20 cm
c) Struts - 15 cm x 20 cm

Timber shoring shall be 'dose' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Employer's Representative. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc., from collapsing.

Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Employer's Representative / PMC Consultant.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be retrieved.

In case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the Employer's Representative. In all other respect, the specification for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavation/ pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

2.5 TRIMMING EXCAVATIONS

When excavating to specified or required levels for the foundation of any structure or to specified or required limits for the face of any structure required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing the constructional work, except where the Employer's Representative shall permit otherwise. Should the Contractor have excavated to within 150mm above these specified levels or to within 150 mm of these specified limits before he is ready or able to commence the constructional work he shall, where required by the Employer's Representative, excavate further so as to remove not less than 150mm of material immediately before commencing the constructional work. Before commencement of any constructional work all shattered and loose material shall be removed from the excavations by hand so as to ensure that the work rest on a solid and perfectly clean foundation or abuts against solid ground.

3.1 PIPE TRENCHES

Trench excavation (as previously defined) means excavation of trenches in to which pipes and cables are to laid and the term pipes shall mean pipes of all kinds and for whatever purpose.

The line and level of trenches shall be as shown on the drawings or as may be directed by the Employer's Representative/ PMC Consultant. Before commencing trench excavation,

the route of the trench shall be pegged out accurately and the natural ground levels shall be agreed with the Employer's Representative / PMC Consultant. Strong sight rails shall then be fixed and maintained at each change of gradient and at as many intermediate points as may be necessary. On these rails shall be marked the centre line and the level to which the excavation is to be carried out, such rails being not more than thirty meters apart.

3.2 TRENCH EXCAVATION GENERALLY

Trench excavation shall be carried out by such methods and to such lines, dimensions arid depths as shall allow for the proper construction of the works, provided always that, unless the Employer's Representative permits otherwise, no trench excavation shall be less than 500mm in width.

Any hard rock in trench excavation shall be so excavated that the clearance between the pipe when laid and the hard rock side and bottom of the trench is kept to the minimum limits necessary to provide for working space and tile specified thickness of bedding haunching and surround to the pipe.

The sides of trench excavation shall be vertical unless the Employer's Representative permits otherwise. Any widening or deepening of trench excavations necessary to accommodate curves, joints or bends in the pipe as required or when ordered by the Employer's Representative/ PMC Consultant shall be provided.

No length of trench excavation shall be started until the pipes to be laid in that length are available on the site.

3.3 TRENCH EXCAVATION IN ROADS AND FOOTPATHS

All trench excavation and other work carried out within the limits of any road shall be completed as rapidly as possible and not more than half of the with of the carriage way shall be obstructed at one time. Road drains and grips shall be kept free from obstruction. In any event the Contractor's shall take special precautions, which shall include the continuous support of the sides of the excavation is begun until the refilling of the trench is placed to ensure that there is no disturbance of the adjacent road or road foundation.

Where excavated material has temporarily been deposited on a grass margin or road pavement, the margin or road pavement shall on completion of refilling be entirely to its original condition and left free from loose stones.

3.4 TRENCH EXCAVATION IN FIELDS, ETC.

The term "fields" includes fields, moor lands, grass verges and the like and all private lands, and no length of trench excavation located in fields shall be commenced until suitable temporary fencing has been erected around that length unless the Employer's Representative permits otherwise. Temporary fencing shall not be removed without the Employer's Representative's permission, which will not normally be given until the trench

excavation had been refilled and reinstated to the original ground condition or as directed by the Employer's Representative.

3.5 SUPPORTING TRENCH EXCAVATIONS

The Contractor shall well and effectually support the sides of trench excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement of or damage to structures adjacent to the excavation. The Contractor shall be deemed to have made his own allowance for any extra excavation necessary to provide space for such support and for any other working space. If for any reason any portion of trench excavation shall give way, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed and making good the same.

Where the Contractor elects and is permitted by the Employer's Representativeto execute trench excavations with battered sides instead of providing support as a foresaid they shall be excavated to stable slopes and heights.

3.6 TRIMMING TRENCH EXCAVATIONS

When excavating to required levels for trench excavations or to required limits from the face of any structure therein required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing constructional work except where the Employer's Representative permits otherwise. Should the Contractor have excavated to within 150 mm above these required levels or to within 150 mm of these required limits before he is ready or able to commence the constructional work he shall, where required by the Employer's Representative, excavate further so as to remove not less than 150 mm of material immediately before commencing the constructional work.

Where no bedding material is required to be laid beneath the pipe, the bottom of trench excavations shall be carefully boned in and trimmed true to grade with the aid of a straight edge at least six metres long so as to ensure a continuous support for the pipes.

The trench bottom shall hen be pricked over with a fork and any stones or flints either likely to cause the pipe to bed unevenly or to damage the pipe and its coating or greater 5 than 20mm in size shall be picked out the pipe bed and any holes so formed shall be filled in with soft material and trimmed to the correct level.

Where no bedding material is required, all shattered and loose material shall be removed from the bottom of the trench excavation so that the bedding material rest on a solid and clean foundation.

3.7 TRENCHES NOT TO BE LEFT OPEN

Trench excavation shall be carried out expeditiously and, subject to any specific requirements of the Contract, the refilling and surface reinstatement of trench excavations

shall be commenced and completed as soon as reasonably practicable after the pipes have been laid and jointed.

Pipe laying shall follow closely upon the progress of trench excavation, and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. The Contractor shall take precautions to prevent flotation of pipes in locations where open trench excavations may become flooded, and these precautions may include the partial refilling of the trench leaving pipe joints exposed while awaiting tests of the joints.

If the Employer's Representative / PMC Consultant considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation.

3.8 REFILLING OF TRENCH EXCAVATIONS

Trench excavations shall be refilled using suitable materials selected from excavations carried out at site or borrow areas as directed by the Employer's Representative/ PMC Consultant.

Soft material (free from stones greater than 75 mm in size for pipes without bitumen sheathing and 20 mm in size for pipes with bitumen sheathing) shall be deposited in 150 mm layers and thoroughly rammed under and around the pipe with suitably shaped rammers working alterrnately on either side of the pipe (particular care being taken to avoid damage to the pipe and any sheathing) until the trench has been refilled upto the swell of the pipe, thereafter until the soft filling has been carried up at least 300mmabove the top of the pipe.

The remainder of the refilling may consist of coarse material (including broken rock from excavation in hard rock) free from boulders and clods of earth larger than 150 mm in size provided that the compacted backfill is, in the opinion of the Employer's Representative sufficiently dense to prevent material from the superimposed layers being washed into the voids in such backfill. This coarse material shall be spread in layers of not greater depth than 225 mm and be thoroughly rammed by an approved mechanical rammer. The coarse filling is to be carried up to the level at which (in roads and footpaths) surface reinstatement is to commence or (elsewhere) to such level as with the surface reinstatement of the whole of the topsoil will leave the finished work sufficiently "proud" to allow for future settlement to the original ground level.

Hard material such as broken rock and original road metalling shall normally be used only for the surface reinstatement of roads as. Specified but where it is suitable and available in sufficient quantity it may be used in place of or as well as the aforesaid coarse material.

Where necessary the Contractor shall adjust the moisture content of the refill material either by drying out or by adding water to assist the compaction of the material.

Should the material being placed as refilling, while acceptable at the time when approved, become unacceptable to the Employer's Representative due to exposure to weather conditions or due to flooding or have become puddle, soft or segregated during the progress of the works, the Contractor shall at his own expense remove such damaged, softened or segregated material and replace it with fresh approved material. Where directed by the Employer's Representative/ PMC Consultant trench excavations shall be refilled with concrete.

4.1. SURFACE REINSTATEMENT IN FIELDS. ETC.

After he has refilled trench excavation in fields and grass verges in the manner and to the level specified, the Contractor shall replace all top soil previously removed and it shall be evenly distributed and leveled over the full extent of the stripped area. Such of the working areas occupied by the Contractor as were originally down to grass shall be sown with grass seed of equivalent quality and maintained until the new grass is properly established.

Other areas not originally down to grass shall be dressed with suitable fertilizers harrowed in so as to restore the original level of fertility.

4.2. SURFACE REINSTATEMENT IN ROADS AND FOOTPATHS

Surface reinstatement of refilled trench excavations in roads and footpaths shall consist of approved backfill material which has been well compacted and brought up to the sub grade level of the adjacent road surface. The balance portion shall be made good with similar material as that of adjacent road, and shall be so maintained (including topping up when necessary) until the end of the Defects Liability Period or until taken over for permanent reinstatement by the appropriate authority, whichever is sooner.

4.3. OTHER STRUCTURES IN THE PIPELINE

The Contractor shall carry out farther excavation as may be necessary to accommodate structures such as thrust blocks and valve chambers. Such excavation shall include for disposal of surplus material and, where appropriate, for backfilling around the structures**.**

4.4. EXISTING SERVICE

Where trench excavation is carried out close to or across the line of sewers, pipes, cables and other services, the Contractor shall, where necessary, provide temporary supports or slings and where such sewer, pipe, cable or other service is temporarily disturbed it shall be replaced.

Where, in the opinion of the Employer's Representative/ / PMC Consultant, construction of the pipeline cannot reasonably be carried out unless the sewer, pipe, cable or other service is permanently severed or permanently diverted or permanently supported by concrete he shall order the Contractor to undertake such work.

Notwithstanding any relevant information furnished by the Employer's Representative, the Contractor shall be responsible for ascertaining from his own inspection of the site and from the respective supply authorities and other public bodies the position of all mains, pipes and cables whether underground or overhead, within or near the site.

4.5. HEDGES, FENCES AND WALLS

Where the trench excavation crosses barriers such as hedges, fences and walls, the Contractor, as a temporary measure during construction of the pipeline, shall provide temporary fencing for any parts of such barriers as have had to be removed.

After trench excavation has been reinstated, the Contractor shall carry out such work as the Employer's Representative may order for permanent restoration of such barriers.

4.6. CROSSING WATERCOURSES. ETC.

Where the pipeline crosses rivers, culverts and other water-courses, the Contractor shall be deemed to have allowed for all the additional measures necessary for the proper construction of the pipeline at these crossings including maintaining the full flow of water across the trench.

4.7. INSPECTION of Works BY THE Employer's Representative/PMC Consultant

When the specified levels or limits of excavation are reached, the Employer's Representative / PMC Consultant will inspect the ground exposed, and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further. Such further excavation shall be refilled to the specified levels or limits with concrete, selected excavated material or selected imported material as directed by the Employer's Representative.

Should the material forming the bottom of any excavation, while acceptable to the Employer's Representativeat the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or due to flooding or have become puddle, soft, or loose during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. Where ever works inspection is involved either Employer's Representative / PMC Consultant shall do the same and shall be recorded and any procedureal changes required for fulfilment of the system shall be done by the contractor at no extar cost.

4.8. EMBANKMENTS

4.8.1. EARTHWORK IN EMBANKMENT

- **Stripping**

The entire area to be occupied by the embankment shall be stripped to a sufficient depth, as determined by the Employer's Representative to remove all materials unsuitable and objectionable for incorporation in embankment.

All excavations below the ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly all as specified for the

embankment fill material, so as to make the surface at these points conform to the surrounding area.

4.8.2. SETTING OUT

After the site has been cleared the limit of embankments shall be set out true to lines as shown on the drawings.

4.8.3. EMBANKMENT CONSTRUCTION

The material used in embankment shall be earth, obtained as indicated in Clause 9.29 and approved by the Employer's Representative. The size of the coarse material in the earth shall not exceed 50mm. Such material shall be free of logs, brush, stumps, roots rubbish, organic matter, humus, or any other unsuitable material likely to deteriorate or affect the stability of the embankment.

The limits of embankments shall be marked by, fixing batten pegs at regular intervals as guides before, commencing the earthwork. It is desirable to fix the pegs about 0.5metre back from the actual limits of the fill and to paint them in a distinctive colour.

In all cases, the original ground under the embankments shall be prepared by scarifying, by ploughing, or by harrows or rakes or by any suitable method, all clods broken and, then moistening in the, range of+1 to -2 % of optimum moisture content and rolling, as directed by the Employer's Representative.

The embankment material shall be spread uniformly over the entire width of the embankment in horizontal layers not exceeding 230 mm and 150 mm in loose thickness, when sheep foot rollers and smooth wheeled rollers respectively are used for compaction. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder:

i) Moisture content of the material shall be checked at the source of supply and -if- found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction, in the latter case, water shall be sprinkled directly from a hose line or from a track-mounted water tank, and flooding shall not be permitted under any circumstances. Moisture content shall be distributed uniformly throughout each layer of the material.

ii) If the material is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction.

iii) Moisture content of each layer of soil shall be so adjusted (making due allowance for evaporation losses) that at the time of compaction it is in the range of 1 percent above to 2 percent below the optimum moisture content determined in accordance with IS : 2720 (Part 7).

iv) After adding the required amount of the water, the soil shall be processed by means of harrows, or as otherwise approved by the Employer's Representative until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have maximum size of 50mm when being placed in the lower layers of the embankment and a maximum size of 25 mm when being placed in the top 0.5-meter portion of the embankment.

Only compaction equipment approved by the Employer's Representative shall be employed. If directed by the Employer's Representativethe Contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials.

Each layer of the material shall be thoroughly compacted to field dry density of not less than 95% of maximum laboratory dry density as per IS : 2720 (Part 7). Frequent laboratory tests to determine optimum moisture content and maximum laboratory dry density for different soil samples being used for embankment construction shall be made. Subsequent layers shall be placed only after the finished layer has been tested, as specified herein after, and accepted by the Employer's Representative. If in the opinion of the Employer's Representativethe surface of the prepared foundation or the compacted surface of any layer of earth fill is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened properly with the layer of material to be placed thereon, it shall be moistened and/or worked with harrow, scarifies, or other suitable equipment, "in an approved manner to a sufficient depth to provide a satisfactory bonding surface before the next succeeding layer of earth fill material is placed. If in the opinion of the Employer's Representativethe compacted surface of any layer of the earth fill in place is too wet for proper compaction of the layer of earth fill material to be placed thereon, it "shall be removed; allowed to dry or be worked with harrow, scarifies or other suitable equipment to reduce the moisture content to the required amount and then it shall be re-compacted before the next succeeding layer of earth fill material is placed.

When field density measurements reveal any soft areas in the embankment, further compaction shall be carried out as directed by the Employer's Representative. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material compacted to the density requirements. The Contractor shall be entitled to no additional allowance above the prices bid in the schedule by reason of any work required due to above conditions.

4.9. DRAINAGE

The surface of the embankment at all times during construction shall be maintained at such a cross-fall as will shed water and prevent flooding. All rainwater shall be drained away from the toe of the embankment. The Contractor shall maintain the embankment in an approved manner till the end of Defects Liability Period.

4.10. PLYING OF CONSTRUCTION TRAFFIC

Construction traffic shall not use the prepared surface of the embankment without the prior permission of the Employer's Representative. Any damage arising cut of such use shall, however, be made good by the Contractor at his own expense**.**

4.11. DISPOSAL OF EXCAVATED MATERIAL (IN EXCESS OF 500M)

All excavated material shall remain the property of . The disposal of excavated material within the plant premises upto a distance of 500M shall, unless the Employer's

Representativeorders otherwise, be at the Contractor's discretion but shall be so arranged as to suit the overall requirements for the construction of the works. This disposal within 500M is covered under the rates for Excavation.

The Contractor shall ensure that no excavated material which is suitable for and is required for re-use in the works is transported unless so ordered by the Employer's Representative.

Excavated materials which are not required for or are unsuitable for reuse in the work shall be disposed to any tipping location designated by the Employer's Representative, all as specified, at a distance from the place of excavation not exceeding ten kilometers by the most direct practicable route. Material disposed off at an Employer's Representativetip at a distance greater than ten kilometers shall qualify for additional payment as decided by the Employer's Representativeat such instance. Material so deposited shall be shaped up or spread and leveled as directed by the Employer's Representative. Any necessary work to provide access to the Employer's Representative tips or other preliminary work in connection there with shall be carried out by the Contractor to the Approval of the Employer's Representative.

4.12. BACK FILLING, GENERAL SITE GRADING & SAND FILLING

i) Fill Material

All fill material whether such material in brought from outside borrow areas or excavation within the site, will be subject to Employer's Representative's approval. Notwithstanding any approval given to the fill material or borrow areas from which fill materials is proposed to be brought, the Employer's Representativereserves the right to reject such material which in his opinion either does not meet the specification requirements or is unsuitable for the purpose for which it is intended.

It shall be the Contractor's responsibility to locate suitable borrow areas for borrowing fill material. Such areas will be inspected by Employer's Representativeand approved before Contractor makes arrangements to borrow the fill material. The top soil which may contain vegetation, rubbish, slush etc. shall not be used. If requested by the Employer's Representative, the Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified, for the Employer's Representativeto examine and nature and type of material likely to be obtained from the borrow areas.

The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty and murrum, ordinary soil, gravel and shingle. Dredged material, free from clayey deposit, may be accepted. Fill material shall also be free from sulphate, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Employer's Representative shall be removed from the site immediately.

Roads, of a temporary nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material, etc. to or over

borrow areas and/or to or over areas on which fill has to be deposited shall be constructed by the Contractor. Such access roads shall be maintained in good condition during all seasons to ensure completion of the work according to the time schedule.

ii) Backfilling

Excavated material used as backfilling to excavations or completed structures shall be free from rubbish, vegetation, clods and lumps and shall be approved by the Employer's Representative. The approved materials shall be placed in layers, not exceeding 225 mm in depth before compaction and shall be compacted to a dry density not less than ninety-five percent of the maximum dry density obtained by the test in Part 7 of I.S. 2720 or to such higher density as it specified hereinafter. During compaction the backfill shall have a uniform moisture content equal to or a little above the optimum moisture content recorded in the LS Compaction Test. Where necessary, the Contractor shall adjust the moisture content of the backfill either by drying out or by adding water. After such drying out or adding of water the backfill shall be thoroughly mixed until the moisture content is uniform.

Should the material being placed as backfilling, while acceptable at the time of selection, become unacceptable to the Employer's Representativedue to exposure to weather conditions or due to flooding or have become puddled, soft or segregated during the progress of the works, the Contractor shall remove such damaged, softened or segregated material and replace it with fresh approved material.

The Contractor shall when placing the backfilling make due allowance for any settlement that may occur before the end of the Defects liability period as defined in the contract. Where necessary, the Contractor shall, during the Defects liability period and at or before the end of the Defects liability period, remove any excess material or make up any deficiency by backfilling to the specified levels. As a rule material to be backfilled shall be stacked temporarily within the basic lead of 500 metres unless otherwise directed by the Employer's Representative.

Compaction shall be carried out to achieve at least 95% of standard Proctor Dry Density at an optimum moisture content determined in accordance with the relevant I.S. specification. It shall be ensured however that the minimum compacted dry density is not less than 16 KN/cum. As the work progress field density tests shall be conducted on each layer at the rate of one test for every 1000 square metres to check whether desired compaction has actually been achieved.

iii) General Site Grading

Site grading shall be carried out as directed by the Employer's Representative. Excavation shall be carried out as specified in the specification. Filling and compaction shall, be carried out as specified under (ii) of this Clause, unless otherwise indicated below :

The approved material shall be placed in layers not exceeding 225 mm in depth before compaction and shall be compacted to a dry density not less than 95 percent of the maximum dry density obtained by the test in Part 7 of IS 2720.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor. Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected materials and make good the slip.

The fill shall be carried out to such dimensions and levels as directed by the Employer's Representative, after the stipulated compaction. The fill will be considered as inoculate if the desired compaction has not been obtained.

If specifically permitted by Employer's Representative, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the Contractor to demonstrate that the desired/specified compaction has been achieved. In order that the fill may be reasonably uniform layers. Traffic over the fill shall then be so routed to contact the area uniformly throughout.

If so specified, the rock as obtained from the excavation may be used for filling and leveling to indicated grades without further breaking. In such event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level indicated above has been carried out, the void in the rockfill shall be filled with finer materials such as earth, broken stone etc. and the area flooded so that the finer fill material does not get washed out. Over the layer, so filled, a 100 mm thick mixed layer of broken material an earth shall be laid and consolidation carried out by a 12 tonnes roller. Not less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

iv) Sand filling below Plinth and Other Places

Backfilling shall be carried out with sand at places as directed by the Employer's Representative. The sand used shall be clean, medium grained and free from impurities. The filled-in sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to the required level or slope. Construction of floors or other structures on sand fill shall not be started until the Employer's Representative has inspected and approved the fill.

4.13. CONCRETE AND ALLIED WORKS

4.13.1. GENERAL

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise, shall conform to the applicable portions of this specification.

The Employer's Representative shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and Employer's Representativeapproval obtained, prior to starting of concrete work.

4.13.2. MATERIALS FOR STANDARD CONCRETE

The ingredients to be used in the manufacture of concrete shall consist solely of Portland cement, clean sand, natural coarse aggregate, clean water and admixtures, if specifically called for on drawings or specifications, or to the approval of the Employer's Representativeif conditions at site warrant its use.

a) Cement

Unless otherwise specified in the Specification or called for by the Employer's Representative, cement shall be ordinary Portland cement (OPC-43 grade) Bags conforming to IS:269 unless specifically defined. The use of bulk cement will be permitted only with the approval of the Employer's Representative. Changing of brands or type of cement within the same structure should be avoided as far as possible.

However cement for all works submerged under water shall be Portland Slag cement 43 grade in 50 kg. Bags conforming to IS:269 unless specifically defined. The use of bulk cement will be permitted only with the approval of the Employer's Representative. Changing of brands or type of cement within the same structure should be avoided as far as possible.

Sample shall be tested at approved Laboratory at Contractor's cost from each lot of cement delivered at site.

The Contractor will have to make his own arrangements for the supply and storage of an adequate quantity of cement. Employer will not supply cement. It will be the responsibility of the Contractor to ensure adequate and proper storage and complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls, and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. The storage arrangement shall be such there is no dead storage. Not more than 12 bags shall be stacked in any tier. The Employer's Representative shall approve the storage arrangement. Consignments cement shall be stored as received and shall be consumed in the order of their delivery.

Cement held in storage for a period of ninety (90) days or longer shall be tested. Should at any time the Employer's Representative have reasons to consider that any cement is defective, then irrespective of it origin, date of manufacture and/or manufacture's test certificate, such cement shall be tested immediately at the Contractor's cost at the approved laboratory and until the results of such tests are found satisfactory, it shall not be used in any work. The Contractor shall not be entitled to any claim of any nature on this account.

b) Aggregates

i) General

'Aggregate" in general designates both fine and coarse inert materials is used in the manufacture of concrete.

"Fine Aggregate" is aggregate most of which passes through 4.75 mm IS sieve.

"Coarse Aggregate" is aggregate most of which is retained on 4.75 mm IS sieve.

All fine and coarse aggregates proposed for use in the Works shall be subject to the Employer's Representative's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Employer's Representative.
Aggregates shall, except as noted above, consist of natural sands, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength shall such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on concrete specified later.

ii) Sampling and Testing

Samples of the aggregates for mix design and determination of suitability shall be taken under the supervision of Employer's Representative and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to Employer's Representative in advance of the work for use in determining aggregate suitability. The costs of all such tests, sampling, etc., shall be borne me by Contractor.

iii) Storage of Aggregates

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers

shall be used for lifting the coarse aggregates from bins or stockpiles. Coarse aggregate shall be piled in layers not exceeding 1.20 meters in height to prevent coning or segregation. Each layers shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after remixing may be accepted, if subsequent tests demonstrate conformance with required gradation.

iv) Specific Gravity

Aggregates having a specific gravity below 2.6 (saturated surface dry basis) shall not be used without special permission of the Employer's Representative.

4.13.3. FINE AGGREGATE

Fine aggregate shall consist of natural or crushed sand conforming to I.S. 383. The sand shall be clean, sharp, hard strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt, or other deleterious substances, which can be injurious to the setting qualities/strength/durability of concrete.

a) Machine-made Sand

Machine-made sand will be acceptable, provided the constituent rock gravel composition shall be sound, hard, dense, non-organic, uncoated and durable against weathering.

b) Screening and Washing

Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size tractions.

c) Foreign Material Limitations

The percentage of deleterious substance in sand delivered to, the mixer shall not exceed the following:

Table 4.1

		Percent by weight	
		Uncrushed	Crushed
i)	Material finer than 75 micron I.S sieve	3.00	15.00
ii)	Shale	1.00	---
iii)	Coal and lignite	1.00	1.00
iv)	Clay lumps	1.00	1.00
v)	Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) and (iv) for Crushed sand	5.00	2.00

d) Gradation

Unless otherwise directed or approved by the Employer's Representative, the grading of sand shall be within the limits indicated hereunder.

Table 4.2

I.S. Sieve Designation	Percentage Passing for Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron I.S. sieve, by total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS. sieve or to percentage passing any other sieve size on the coarser limit of Grading Zone I or the finer limit of Grading Zone IV. Fine aggregates conforming to Grading Zone IV shall be used unless mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

e) Fineness Modulus

The sand shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentages retained on the following I.S. sieve sizes (4.75mm, 2.36mm, 1.18mm, 600micron, 300micron and 150micron) and dividing the sum by 100.

4.13.4. COARSE AGGREGATE

Coarse aggregate for concrete, except as noted above, shall conform to IS: 383. This shall consist of natural or crushed stone and gravel, and shall be clean, and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

a) Screening and Washing

Natural gravel and crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so directed by the Employer's Representative.

b) Grading

Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits :

Table 4.3

I.S Sieve Desig-nation	Percentage passing for single sized aggregate of nominal size					Percentage passing for Graded aggregate of nominal size			
	40 mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5mm
63 mm	100	--	--	--	--	100	--	--	--
40 mm	85-100	100	--	--	--	95-100	100	--	--
20 mm	0-20	85-100	100	--	--	30-70	95-100	100	--
16 mm	--	--	85-100	100	--	--	--	90-100	--
12.5 mm	--	--	--	85-100	100	--	--	--	90-100
10 mm	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	--	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm	--	--	--	--	0-5	--	--	--	--

The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only in such quantities that will not, in the opinion of the Employer's Representative, affect adversely the strength and/or durability of concrete. The maximum size of coarse shall be the maximum size specified above, but in no case greater than 1/4 the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. Plums above 160 mm and upto any reasonable size can be used in plain mass concrete work of large dimensions upto a maximum limit of 20% by volume of concrete when specifically approved by Employer's Representative. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover to the reinforcement whichever is smaller. The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per I.S, 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of its oven dry weight in air, as determined by I.S. 2386.

c) Foreign Material Limitations

The percentage of deleterious substances in the aggregate delivered to the mixer shall not exceed the following:

TABLE 4.4 :

S.N.	Foreign Material	Percent by weight	
		Uncrushed	Crushed
i)	Material finer than 75 micron I.S Sieve	3.00	3.00

ii)	Coal and lignite	1.00	1.00
iii)	Clay lumps	1.00	1.00
iv)	Soft fragments	3.00	----
v)	Total of all the above substances	5.00	5.00

4.13.5. WATER

Water used for both mixing and curing, shall be free from injurious amounts of deleterious materials. Potable water is generally satisfactory for mixing and curing concrete.

In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in I.S. 456. The sample of water for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 day compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of I.S. 516.

The initial setting time of test block made with the appropriate test cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than ±30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of I.S. 4031.

Where water can be shown to contain an excess of acid, alkali, sugar or salt, Employer's Representative may refuse to permit its use. As a guide, the following concentrations represent the maximum permissible values:

(a) To neutralize 200 ml, sample of water, using Phenolphthalein as indicator, it should not require more than 2 ml. of 0.1 Normal NaOH. The details of test shall be as given in I.S: 3025.

(b) To neutralize 200-ml. sample of water, using methyl orange, as an indicator should not require more than 10 ml. of 0.1 Normal HCL. The details of test shall be as given in I.S: 3025.

(c) Percentage of solids, when tested in accordance with the method indicated below, shall not exceed the following:

TABLE 4.5 :

Solids	Percent	Method of Test

		(Ref. to Cause No. In IS :3025)
Organic	0.02	10 and 11 (organic solids = total solids minus ignited residue)
Inorganic	0.30	11 (ignited residue)
Sulphates (as SO4)	0.05	20
Alkali Chloride (As Cl)	0.20	24
Suspended matter	0.20	12

4.14. STEEL MEMBERS ENCASED IN CONCRETE

Structural steel columns, beams, girders and bracings to be encased in concrete shall be unpainted. The encasing shall be done in concrete with 10 mm maximum size aggregate and works cube strength not less than 15 N/mm2 at 28 days unless otherwise specified. The steel member shall be wrapped with galvanised wire mesh of adequate size.

All stell members in the floor level in tanks contact with water shall be embeed in concrete for min. 450 mm above the fished floor level.

The galvanised wire mesh shall be at 20 mm from the edge or surface of the steel member and shall be held in position securely. The steel, member will have a minimum cover of 50 mm unless otherwise indicated on the drawings. Where the clear cover to steel is more than 75mm, mild steel bar and concrete with 20 mm coarse aggregate can be used.

4.14.1. CONTROLLED CONCRETE

All concrete in the works shall be "controlled concrete" as defined in IS 456, except for M7.5 and M10 for which nominal mix concrete shall be used. Whether reinforced or otherwise, all concrete works to be carried out under this specification shall be divide into the following classification:

TABLE 4.6 :

MINIMUM COMPRESSIVE STRENGTH OF 15 CM. CUBES AT 7 AND 28 DAYS AFTER MIXING CONDUCTED IN ACCORDANCE WITH IS : 516

Class	Preliminary test N/mm2		Works test N/mm2		Maximum size of aggregate	Locations for use
	At 7 days	At 28 days	At 7 days	At 28 days		
M40	33.5	50.0	27.0	40.0	20	As indicated in the specificaitons or as required.
M35	30.0	44.0	23.5	35.0	20	-do-
M30	25.0	38.0	20.0	30.0	40 or 20	-do-

M25	22.0	32.0	17.0	25.0	40 or 20	-do-
M20	17.5	26.0	13.5	20.0	40 or 20	-do-
M15	13.5	20.0	10.0	15.0	40 or 20	-do-

Notes: It shall be very clearly understood that whenever the concrete such M 20, etc. is specified it shall be Contractor's responsibility to ensure that minimum crushing strength stipulated for the respective grade of concrete is obtained at works.

Minimum cement content in the concrete used for liquid/ water retaining structure shall be 360 kg/m3 for 20 mm downgraded aggregate and 325 kg/m3 for 40 mm downgraded aggregate.

4.14.2. MIX DESIGN

a) General

This is to investigate the grading of aggregates, water cement ratio, workability and the quantity of cement required to give preliminary and works cubes of the minimum strengths specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made.

Determination of mix proportions shall be carried out according to "Recommended Guidelines for Concrete Mix Design' conforming to IS: 10262.

Whenever there is change either in required strength of concrete, or water-cement ratio or workability or the source of aggregates and/or cement, preliminary tests shall be repeated to determine the revised proportions of the mix to suit the altered conditions. While designing mix proportions, over-wet mixes shall always be avoided.
While fixing the value for water/cement ratio for preliminary mixes, assistance maybe derived from IS: 456.

b) Preliminary Tests

Test specimens shall be prepared with at least two different water/cement ratios for each class of concrete, consistent with workability required for the nature of the work.

The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce concrete of required consistency and to give the specified strength. It will be Contractor's sole responsibility to carry out these tests and he shall therefore furnish to Employer’s Representative a statement of proportions proposed to be used for the various concrete mixes. For preliminary tests, the following procedure shall be followed :

Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water, cement and aggregates for each batch shall be determined by weight to an accuracy of 1 part in 1000 parts.

(i) Mixing Concrete

It shall be done by hand or in a small batch mixer as per I.S. 516 in such a manner as to avoid loss of water. The cement and fine aggregate shall first be mixed dry until the mixture is uniform in colour. The coarse aggregate shall then be added, mixed and water added and the whole batch mixed thoroughly for a period of not less than two minute until the resulting concrete is uniform in appearance. Each batch of, concrete shall be of such a size as to leave about 10% excess concrete, after moulding the desired number of test specimens.

(ii) Consistency

The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with I.S.1199. If in the slump test, care is taken to ensure that no water or other material is lost, the material used for the slump test may be remixed with the remainder of the concrete for making the specimen test cubes. The period of re-mixing shall be as short as possible yet sufficient to produce a homogeneous mass.

(iii) Size of Test Cubes

Compression tests of concrete cubes shall be made as per I.S.516 on 15 cm. cubes. Each mould shall be provided with a metal base plate having a plain surface so as to support the mould during filling without leakage.

The base plate shall be preferably attached to the mould when assembled shall be positively and rigidly held together. Before placing concrete, the mould and base plate shall be cleaned and oiled. The dimensions and internal faces of the mould shall be accurate within the following limits:

Height and distance between the opposite faces of the mould shall be of specified size +0.2 mm. The angle between the adjacent internal faces and between internal faces and top and bottom faces of mould shall be 90 +_ 0.5°. The interior faces of the mould shall be plain surface with a permissible variation of 0.03 mm.

(iv) Compacting

Concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in I.S. 516.

(v) Curing

Curing shall be as specified in I.S.516. The cubes shall be kept in moist air of at least 90% relative humidity at a temperature of 27° ±_2° C for 24 hours ±1/2 hour from the time of adding water to the dry ingredients. Thereafter they shall be removed from the moulds and kept immersed in clean, fresh water and kept at 27° ± 2° C temperature "until required for test. Curing water shall be renewed every seven days. A record of maximum temperatures at the place of-storage of the cubes shall be maintained during the period they remain in storage.

(v) Testing of Specimens

The strength shall be determined based on not less that five cube test specimens for each age and each water cement ratio. All these laboratory test results shall be

tabulated and furnished to the Employer's Representative. The test results shall be accepted by the Employer's Representativeif the average compressive strength of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested subject to the condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. The Employer's Representativemay direct the Contractor to repeat the tests if the results are not satisfactory and also make such changes as he considers necessary to meet the requirement specified. All there preliminary tests shall be conducted by the Contractor at his own cost in approved laboratory.

4.14.3. PROPORTIONING, CONSISTENCY, BATCHING AND MIXING OF CONCRETE

a) Proportioning

(i) Aggregate

The proportions which shall be decided by conducting preliminary tests shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weigh batchers conforming to I.S. 2722 capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Employer's Representative that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions.

The different sizes shall be stocked in separate stock piles. The grading of coarse and fine aggregate shall be checked as frequently as possible, as determined by the Employer's Representative, to ensure maintaining of grading in accordance with the samples used in preliminary mix design. The material shall be stock piles well in advance of use.

(ii) Cement

Cement shall be measured by weight.

(iii) Water

Only such quantity of water shall be added to the cement and aggregates in the concrete mix as to ensure dense concrete, specified surface finish satisfactory workability, consistent with the strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause aggregation of materials or the collection of excessive free water on the surface of the concrete.

(iv) Definition of Water/ Cement Ratio

The water cement (W/C) ratio is defined as the weight of water in the mix (including the surface moisture of the aggregates) divided by the weight of cement in the mix.

(v) Water/ Cement Ratio

The actual water cement ratio to be adopted shall be determined in each instance by the Contractor and approved by the Employer's Representative.

(vi) Proportioning by Water/ Cement Ratio

The W/C ratio specified for use by the Employer's Representativeshall be maintained. The Contractor shall determine the water content of the aggregates as frequently as directed by the Employer's Representativeas the work progresses and as specified in I.S. 2386 (Part ID) and the amount of mixing water added at the mixer shall be adjusted as directed by the Employer's Representative so as to maintain the specified W/C ratio. To allow for the variation in weight of aggregates due to variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made,

b) Consistency and Slump

Concrete shall be of consistency and workability suitable for the conditions of the job. After the amount of water required is determined, the consistency of the mix shall be maintained throughout the progress of the corresponding parts of the work and approved tests e.g. slump tests, compacting factor tests, in accordance with I.S.1199, shall be conducted from time to time to ensure the maintenance of such consistency.

The following tabulation gives a range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Employer's Representative:

TABLE 4.7 :
SLUMPS FOR VARIOUS TYPES OF CONSTRUCTION

Works Details	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings and substructure walls	75	25
Slabs, Beams and reinforced walls	100	25
Pumps & Miscellaneous Equipment foundations	75	25
Building Columns	100	25
Pavements	50	25
Heavy Mass Construction	50	25

c) Batching and Mixing of Concrete

The materials and proportions of concrete materials as established by the preliminary tests for the mix designs shall be rigidly followed for all concrete on the Works and shall not be changed except when specifically permitted by the Employer's Representative.

Concrete shall be produced only by weigh batching the ingredients. The mixer and weigh batchers shall be maintained in clean, serviceable condition. The accuracy of weigh batchers shall be periodically checked. They shall be set up level on a firm base and the hopper is empty. Fine and coarse aggregates shall be weighed separately. Volume batching will not be permitted. However, the Employer's Representative may permit

volume batching by subsequent conversion of the weights of the aggregate into their equivalent volumes knowing their bulk densities, only in the case of small and less important pours involving weigh batching are not likely to be taken up. Concrete shall be of strength stipulated in the respective items. All concrete shall be mixed in mechanically operated batch mixers complying with I.S.1791 and of the approved make with suitable provision for correctly controlling the water delivered to the drum. The quantity of water actually entering the drum shall be checked with the reading of the gauge or valve setting, when starting a job. The test should be made while the mixer is running. The volume of the mixed material shall not exceed the manufacturer's rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum in advance of cement and aggregates. All water shall be in the drum by the end of the first 15 seconds of the specified mixing time.

Each batch shall be mixed until the concrete is uniform in colour, for a minimum period of two minutes after all the materials and water are in the drum. The entire contents of the drum shall be discharged in one operation before the raw materials for the succeeding batches are fed into the drum. Each time the work stops, the mixer shall be cleaned out and when next commencing the mixing, the first batch shall have 10% additional cement to allow for sticking in the drum.

4.15. MIX DESIGN REINFORCED CONCRETE – M15, M20, M30,M35,M40

- All water reating structures shall be designed as per IS3370 part I to IV.
- The works under this head covers all acitivities including raw materials, transportation to site, Reinforced Cement Concrete grades M15, M20, M30 shall be mix design as specified in General Specifications. In case WPC is required to be added (if specified), same shall conform with general specifications in all respects. Admixtures, as specified in General Specifications, shall be added, if directed by Employer's Representative depending on grade of concrete and construction requirements without any extra cost implication. Minimum M 25 grade for buildings and M-30 for Water Reating Structures shall be used, no grade below the said is permissible.
- Only Natural sand is allowed, no crushed sand is permissible.
- Suplhur Resitant cenemt to be used in contrction of RCC manholes.

- Contractor shall comply with all testing requirements as specified in General Specifications for raw materials and concrete (for all grades of concrete).

4.15.1. NOMINAL MIX CONCRETE – M10

- Nominal mix concrete, used in plain concrete works, shall be of grade M10. The Nominal mix concrete shall conform to the requirements of General specifications in all respects.

4.15.2. SAMPLING AND TESTING CONCRETE IN THE FIELD

As per **FQP**

4.15.3. ADMIXTURES

a) General

Admixtures may be used in concrete where required, only with the approval of the Employer's Representative based upon evidence that, with the passage of time, neither the compressive strength not its durability reduced.

Calcium chloride shall not be used for accelerating set of the cement for concrete containing reinforcement, or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1 1/2 % of the weight of the cement in each batch of concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instructions and in the manner and with the control specified by the Employer's Representative.

b) Air Entraining Agents

Neutralized vinsol resin or any other approved air entraining agent may be used to produce the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6-20. Air entraining admixtures for concrete. The recommended total air content of the concrete is 4% ± 1%. The method of measuring air content shall be as per IS: 1199.

c) Water Reducing Admixtures

Water reducing lignosulfonate admixture may be added in quantities approved by the Employer's Representative. The admixtures shall be added in the form of a solution.

d) Retarding Admixtures

Retarding agents may be added to the concrete mix in quantities approved by the Employer's Representative.

e) Water-Proofing Compound

i) As directed by the Employer's Representative, the Contractor shall use approved waterproofing compound made by manufacturers as per list of makes in Section-X, Volume-2, Employers requirement. In the reinforced concrete works. The quantity to be used shall be two percent by weight of cement or shall be in accordance with the manufacturer's instructions subject however to the approval of the Employer's Representative. The compound shall not contain calcium chloride and shall conform to IS: 2645.

ii) Mixing water proofing compound with cement. The compound should be mixed thoroughly with the cement by hand before the cement is mixed with aggregate. Thorough mixing is essential. The two materials should be heaped on a mixing board thoroughly turned over several times with a shovel and finally passed through a fine sieve. If labour is unsatisfactory the sieving should be done twice to ensure maximum dispersal of the compound throughout the cement.

iii) **Mixing the concrete**

The mixture of water proofing compound and cement should then be added to the aggregate, the dry materials turned over twice and the correct amount of water then added through a rose spray, A further thorough mixing by spade should immediately follow. Only the minimum quantity of water necessary to give workability should be used such that it will make the concrete just sufficiently plastic for purposes of placing and thorough consolidation without affecting its strength.

f) Corrosion Inhibators

Corrosion Inhibators shall be added to concreting for water reating structures in contact with water as well for use of concrete to embeed the structural steel.

4.15.4. CONCRETE IN ALKALI SOILS AND ALKALINE WATER

Where concrete is vulnerable to attack from alkali salts or alkaline water, special cements containing low amount of tricalcium aluminate shall be used, if so specified or directed. Such concrete shall have a minimum 28 days compressive strength of 25 N/mm2 and shall contain not less than 3.7 KN of cement per cubic metre of concrete in place. If specified, additional protection shall be obtained by the use of chemically resistant stone facing or a layer of Plaster of Paris covered with suitable fabric, such as jute thoroughly impregnated with tar.

4.15.5. PREPARATION PRIOR TO CONCRETE PLACEMENT. FINAL INSPECTION AND APPROVAL

Before the concrete is actually placed in position, the insides of the formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection, especially of bottoms of columns and wall forms, to permit removal of saw dust wood shavings, binding wire, rubbish, dirt, etc. Openings shall be placed or holes drilled so that these materials and water can be removed. Such openings/holes shall be later suitably plugged. The various trades shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedded to be cat in the concrete as specified or required or as is necessary for the proper execution of the work.

All embedded parts, inserts, etc., supplied by the Corporation or the Contractor shall be correctly positioned and securely held in the forms, to prevent displacement during depositing and vibrating of concrete.

All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by the Employer's Representative.

Slots, openings, holes, pockets, etc., shall be provided in concrete work in the positions specified or required or as directed by the Employer's Representative.

Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

Prior to concrete placement all work shall be inspected and approved by the Employer's Representative and if found unsatisfactory, concrete shall not be poured until all defects have been corrected.

Approval by the Employer's Representative of any and all materials and work as stated herein shall not relieve the Contractor from his obligation to produce finished concrete in accordance with the requirements of the specification.

a) Rain or Wash Water

No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rains shall entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage which may be used by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work ended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such is removed. To avoid flow of water over/around freshly placed concrete, suitable drains .and sumps shall be provided.

b) Bonding Mortar

Immediately before concrete placement begins, prepared surfaces except formwork, which will come in contact with the concrete to be placed, shall be covered with a bonding mortar as specified.

5.1 TRANSPORTATION

a) General

All buckets, containers or conveyors used for transporting concrete shall be mortar-tight. Irrespective of the method of transportation adopted, concrete shall be delivered with the required consistency and plasticity without segregation or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of the Employer's Representative and concrete shall not be re-handled before placing.

b) Re tempered or Contaminated Concrete

Concrete must be placed in its final position before it becomes too stiff to work. On no account, water shall be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials shall be rejected and disposed off as directed by the Employer's Representative.

c) Cleaning of Equipment

All equipment used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipelines and other equipment shall be thoroughly cleaned after each period of placement.

4.16. PROCEDURE FOR PLACING OF CONCRETE

a) Employer's Representative's Approval for Equipment & Methods

Before any concrete is placed, the entire placing programme, consisting of equipment, layout, proposed procedures and methods shall be submitted to the Employer's Representative for approval if so demanded by the Employer's Representativeand no concrete shall be placed until Employer's Representative approval has been received equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

b) Time Interval between Mixing and Placing

Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within Ninety minutes of leaving the mixer, and once compacted it shall not be disturbed.

c) Avoiding Segregation

Concrete shall in all cases, be deposited as nearly as practicable directly in its final position, and shall not be re-handled or caused to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts, or impair its strength. For locations where direct placement is not possible, and in narrow forms, the Contractor shall provide suitable drop and "Elephant Trunks" to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin walls.

d) Placing of Manual Labour

Except when otherwise approved by the Employer's Representative, concrete shall be placed in the shuttering by shovels or other approved implements, and shall not be dropped from a height more than 1.0 m or handled in a manner which will cause segregation.

e) Placing by Mechanical Equipment

The following specification shall apply when placing of concrete by use of mechanical equipment is warranted considering the nature of work involved.

The control of placing shall begin at the mixer discharge. Concrete shall be discharge by a vertical drop into the middle of the bucket or hopper and the principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

i) Type of Buckets

Central-bottom-dump buckets of a type that provides for positive regulation of the amount and rate of deposition of concrete in all dumping positions, shall be employed.

ii) Operation of Bucket

In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall clear the concrete already in place and the height of drop shall not exceed 1.0 m. the bucket shall

be opened slowly to avoid high vertical bounce. Dumping of buckets on the swing or in any manner which results in separation if ingredients or disturbance of previously placed concrete will not be permitted.

f) Placement in Restricted Forms

Concrete placed in restricted forms by barrows, buggies, cars, short chutes or hand shovelling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position.

g) Chuting

Where it is necessary to use transfer chutes, specific approval of Employer's Representative must be obtained to type, length, slopes, baffles, vertical terminals and timing of operations. These shall be so arranged that an almost continuous flow of concrete is obtained at the discharge end without segregation. To allow for the loss of mortar against the sides of the chutes, the first mixes shall have less coarse aggregate. During cleaning of chutes, the waste water shall be kept clear of the forms. Concrete shall not be permitted to fall from the end of the chutes by more than 1.0 m. chutes, when approved for use, shall have slopes not flatter than 1 vert : 3 horiz. And not steeper than 1 vert : 2 horiz. Chutes shall be of metal or metal lined and of rounded cross section. The slopes of all chute sections shall be approximately the same. The discharge end of the chutes shall be maintained above the surface of the concrete in the forms.

h) Placing by Pumping / Pneumatic Placers

Concrete may be conveyed and placed by mechanically operated equipment e.g. pumps or pneumatic placers only with the written permission of the Employer's Representative. The slump shall be held to the minimum necessary for conveying concrete by this method.

When pumping is adopted, before pumping of concrete is started, the pipeline shall be lubricated with one or two batches of mortar composed of one part cement and two parts sand. The concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

When a pneumatic placer is used, the manufacturer's advice on layout of the pipeline shall be followed to avoid blockages and excessive wear. Restraint shall be provided at the discharge box to cater for the reaction at this end.

Manufacturer's recommendations shall be followed regarding concrete quality and all other related matters when pumping/ pneumatic placing equipment is used.

i) Concrete In Layers

Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 cm to 90 cm as directed by Employer's Representative. These shall be placed as rapidly practicable to prevent the formation of cold joints or places of weakness between each

succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth arid texture with a minimum of shovelling. Any tendency to segregation shall be corrected by shovelling stones into mortar rather than mortar on to stones. Such a 'condition' shall be corrected by redesign of mix or other means, as directed by the Employer's Representative.

j) Bedding of Layers

The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed.

k) Compaction

Concrete shall be compacted during placing, with approved vibrating equipment until the concrete has been consolidated to the maximum practical density, is free of pockets of coarse aggregate fits tightly against all form surfaces, reinforcement an embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into comers of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point that segregation results.

i) Type of Vibrators

Vibrators shall conform to IS specifications. Type of vibrator to be used shall depend on the structure where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the formwork which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators shall have "no load" frequency, amplitude and acceleration as per IS: 2505 depending on the size of the vibrator. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

ii) Use of Vibrators

The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of a lift e.g. in a column or wall.

iii) Melding successive Batches

When placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the succeeding layers.

iv) Penetration of Vibrator

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

v) Vibrating against Reinforcement

Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come in contact with forms or finished surfaces.

vi) Use of Form Attached Vibrators

Form attached vibrator shall be used only with specific authorization of the Employer's Representative.

vii) Use of Surface Vibrators

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, such as highways, runways and similar construction, surface vibration by specially designed vibrators, may be permitted, upon approval of Employer's Representative.

viii) Stone Pockets and Mortar Pondages

The formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for through bonding, as directed by the Employer's Representative.

l) Placement Interval

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete and before the start of a subsequent placement.

m) Special Provision in Placing

When placing concrete in walls with openings, in floor of integral slab and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be. Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by the Employer's Representative.

n) Placing Concrete through Reinforcing Steel

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position and the Employer's Representative's approval shall be obtained prior to adopting this method.

o) Bleeding

Bleeding or free water on top of concrete being deposited into the forms, shall be cause to stop the concrete pour and the conditions causing this defect corrected before any further concreting is resumed.

4.17. BONDING OF NEW AND OLD CONCRETE

a) General

Epoxy resins may be used to bond fresh concrete to concrete that is fully cured, to give a monolithic bond capable of transmitting high stresses when traditional bonding agents such as cement slurry cannot always be relied upon to provide good adhesion which is particularly the case when large areas are involved.

The formulation shall be applied to a suitably prepared concrete substrata and the fresh concrete poured as soon as possible, but always during the 'open time' of the adhesive. Material used shall be of best quality and approved by .the Employer's Representative. Manufacturer's instruction shall be followed in all respects.

Prefeablly a Acrylic emulsion cement modifier shall be used.

b) Application

i) Preparation of the Substrata

To obtain good adhesion it is necessary to have a clean and sound substrata. Preparation can be carried out using a variety of techniques including chemical treatment and mechanical methods such as grinding, milling abrading, planning and sand blasting. Dust and loose particles resulting from the pre-treatment should be removed by vacuum cleaning or oil-free air blast.

ii) Mixing

The resin and hardener should be thoroughly mixed before mixing in the dry filler. The mixed, ready to use adhesive should not contain lumps of unwetted filler and should be of a uniform colour. For a total weight of 1 kilogram or less, hand mixing should be sufficient. For quantities in excess of 1 kilogram, the use of a mechanical mixer is recommended.

iii) Pot life and 'Open Time'

The pot life is the period during which the ready to use Araldite based formulation must be applied. After this period the mix can no longer be worked and will have begun to set in its container. The table below indicates the pot life at different temperatures :

Table 4.8

Max. temperature ^{0}C	Pot life in minutes
25	90
30	60
35	45

The 'open time' is the maximum period of time allowable between application of the ARALDITE adhesive and pouring the fresh concrete. Exceeding the 'open time' would result in considerably reduced adhesion.

The adhesive should be applied to the pre-treated substrata as soon as the components have been mixed and fresh concrete poured immediately afterwards.

Accurate knowledge of the 'open time' is essential in case the work in interrupted.

Table 4.9

Substrate temperature ^{0}C	Open Time
35	30 Minutes
30	1 Hour
25	1.75 Hours
23	3 Hours

Table 9.9 gives the 'open time' of ARALDITE base formulations as a function of substrata temperature. In all cases the adhesives shall be applied immediately after mixing. Any delay between mixing and application will reduce the 'open time'. Fresh concrete must be poured before the adhesive begins to gel. New to old concrete bonding is not recommended at temperatures below 5°C as adequate curing cannot be assured under these circumstances.

iv) Methods of Application

The shape and size of the concrete structure will determine the method of application used. The ARALDITE based adhesive may be applied by hand using brushes, brooms or any other suitable applicator.

v) Suitability of the Fresh Concrete

Best results are obtained when the water/cement ratio of the new concrete is as low as is practicable.

vi) Coverage

One kilogram of the mixed ARALDITE adhesive including hardeners and thinner covers an area of 2.3 sq. metres when applied with a stiff nylon bristle brush. However, the coverage is very much dependent on the finish in the concrete.

c) Handling Precautions

Epoxy resins can cause irritation of the skin of the persons if incorrectly handled. Certain safety precautions must therefore be observed and those handling the resins and hardeners should be given suitable instructions. Those working with epoxy resins should, above all, be instructed that personal cleanliness at the place of work is essential. The resin and hardener should not be allowed to come into direct contact with the skin. The most effective protection is achieved by wearing rubber or polythene gloves, the later

having the advantage that they can be replaced when dirty. They are most pleasant to wear if cotton gloves are worn underneath. Parts of the skin which have come into contact with the resin or hardener should be washed with lukewarm water and a mild soap. Special cleaning creams have also proved to be highly suitable.

4.18. CONSTRUCTION JOINTS

A construction joint is defined as a joint in the concrete introduced for convenience in construction at which special measures are taken to achieve subsequent continuity without provision for further relative movement.

All the drawings submitted for the Employer's Representative's approval shall indicate position of all construction joints and lifts. No concreting shall be started until the Employer's Representative has approved the method of placing, the positions and form of the construction joints and lifts. The construction joints shall be so located as not to impair the strength of the structure. Rebates, keys or notches shall be formed and water stops inserted as the Employer's Representative may require. The position of construction joints and the size of the formwork panels shall be so coordinate that where possible the line of any construction joints coincides with the line of a formwork joint and that in any case all construction joint lines and formwork joint lines appear as a regular and uniform series. For all exposed horizontal joints and purposely inclined joints, a uniform joint shall be formed with a batten of approved dimensions to give a straight and neat joint line.

Concrete placed to form the face of a construction joint shall have all laitance removed and the aggregate exposed prior to the placing of fresh concrete. The laitance shall wherever practicable be removed by spraying the concrete surface with water under pressure and brushing while the concrete is still green. Where the laitance cannot be removed while the concrete is still green the whole of the concrete surface forming part of the joint shall be hacked to expose the aggregate. Where aggregate is damaged during hacking it shall be removed from the concrete face by further hacking. All loose matter shall be removed and the exposed surface thoroughly cleaned by wire brushing, air blasting or washing, leaving the surface clean and damp. Immediately before fresh concrete is placed a 12 mm thick layer of sand/ cement mortar mixed in the same proportions as in the concrete shall be spread in the horizontal face of the construction joint. A drier mix shall be used for the top lift of horizontal pours to avoid laitance. The new concrete shall be well worked against the prepared face before the mortar sets. Special care shall be taken to obtain through compaction and to avoid segregation of the concrete along the joint plain.

4.19. MOVEMENT JOINTS

Movement joints are defined as all joints intended to accommodate relative movement between adjoining parts of a structure, special provision being made where necessary for maintaining the water tightness of the joint. The Contractor shall comply with the instructions of manufacturers of proprietary jointing materials and shall, if required by the Employer's Representative, demonstrate that the jointing materials can be applied satisfactorily.

The Contractor shall show locations of all movement joints and details thereof on drawings submitted for the Employer's Representative's approval.

The surface of set concrete in a movement joint shall, as shown on the Drawings, be painted with two coats of bituminous paint and new concrete shall be placed against it only when the paint is dry. Expansion joints shall be formed by a separating strip of approved performed joint filler. Caulking grooves shall be provided. At all joints where a caulking groove is formed, immediately prior to caulking, the groove shall be wire brushed and loose material removed and blown out by compressed air. After the groove has dried, it shall be primed and caulked with approved sealing compound applied in accordance with the manufacturer's instructions. At all caulked joints, the face of the caulking strip and a 50 mm width of concrete on either side shall be painted with two coats of paint having the same base as the sealing compound.

4.20. WATER STOPS AND JOINT FILLERS

At all vertical construction joints in walls of water retaining structures and all expansion joints in the water retaining structures and wherever specified or directed by the Employer's Representative, water stops shall be provided. The water stops shall be of synthetic grade rubber and shall be as follows:

i)	Tensile strength not less than	20 N per sq.mm
ii)	Elongation at break not less than	500%
iii)	Modulus at 300% elongation	5.1 N per sq.mm
iv)	Specific gravity	1.12
v)	Compression set / constant deflection percent of original deflection at 70^0C for 22 hrs.	24% max.
vi)	Change in weight water immersion (2 days at 70^0C)	1.6% max.
vii)	Tensile strength and elongation at break as % of original, after oxygen pressure test 48 hours, 70^0C, 21.1 kgf per sq.cm before ageing	
	Tensile strength	85% min.
	Elongation at break	83% min.

Water stops shall not be exposed to direct sunlight for long periods. Before being concreted, water stops shall be cleaned of all foreign materials. Wherever provided, water stops shall be placed in such a manner that they are embedded in the adjacent sections of the panels for equal width.

The storage, fixing in position, splicing of water stops shall be as per manufacturer's instructions.

Water stops shall be fully supported in the form work, free of nails and clear of reinforcement and other fixtures. Damaged water stops shall be replaced and during concreting care shall be taken to place concrete so that water stops do not bend or distort

The different type of water stops to be used in liquid retaining structures shall be as follows:

TABLE 4.10

	Type of Joint	Type of Water Stops
1.	Partial / complete contraction joint in walls and slabs	150 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
2.	Expansion joints in walls and slabs	225 ram wide, ribbed with hollow centre bulb and 9 mm minimum thickness
3.	Construction joint in raft	225 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
4.	Construction joint in wall	150 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
5.	Partial/ complete contraction joint in raft	225 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness
6.	Expansion joint in raft	225 mm wide, ribbed with hollow centre bulb and 5 mm minimum thickness

4.21. JOINT FILLERS

Joint fillers shall be of durable, compressible, and non-extruding material. The joint filler shall be thermocole TF quality of thickness 25 mm. The side face of reinforced concrete member shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen, conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 kg/sq.m.

Thermocole boards (TF quality) of 25 mm thickness shall be stuck means of the same grade of hot bitumen. The joints of the boards shall be sealed with bitumen. Holes in joint filler to accommodate the dowel bars shall be accurately done to produce a sliding fit on the dowel bars.

4.22. BITUMEN PAINT

The material shall be of the best quality unpig mented bituminous base paint of such a composition as to satisfy the requirements of IS: 9862 where total volatile matter contained in the paint shall not exceed 55% by weight.

At least 95% of the solid materials shall be soluble, in carbon di-sulphide or in benzene, and the closed flash point as determined in Abel's apparatus shall not be less than (86°F)30°C. The paint shall remain liquid and retain its consistency at the ordinary atmospheric temperature when packed in suitable containers. The drying time shall not be less than 2 hours and not more than 8 hours and after drying, the paint shall not show any surface cracks, tendency to powder or discoloration due to weathering action or expansion and contraction, It shall also be able to resist the action of acids and alkalis. It shall soften under the action of mineral turpentine.

The film resulting from brushing the material on a strip of tinned iron, 30 standard wire gauge after being allowed to dry at room temperature not below (65°F) 18.3°C for 48 hours shall not when bent do1.lble over a (quarter inch) 6 mm dia rod, shown any signs of flaking or cracking. The time occupied for the actual bending shall not exceed" one second. When the paint has dried hard, a 4 H pencil should not be capable of scratching it. The weight of the paint shall be from 0.83 to 1.25 kg per litre, the component of the paint shall be such as not to react the water chlorinated or otherwise and develop poisonous or harmful elements thereto.

The paint shall be of Indian manufacture of approved make and quality.

4.23. BITUMENT KRAFT PAPER

The Bitumen Kraft paper shall comprise of two plies or kraft paper laminated with bitumen. It shall conform to type 1 of IS: 1398. It shall be free of cracks. The adhesion between the plies shall be such that they cannot be separated by pulling apart with hands after conditioning as per Clause 2.1 of IS: 1060 Part I without damaging the paper. Its minimum bursting strength should be 2.3 kgs / sq / cms. Its tensile strength shall be as per IS: 1398.

4.24. SEALING COMPOUND

The sealing compound shall satisfy the following requirements.

(a) To seal the joints against passage of water.
(b) To prevent ingress of grit or other foreign matters and
(c) To provide protection to the joint filler where necessary.

The various characteristic properties of the sealing compound those require consideration are adhesion, good extensibility, resistance to flow, resistance to ingress of foreign matter, resistance to weathering and resistance to oil, fuel and fat.

For application of, the sealing compounds the concrete shall be in dry condition. The subsequent climatic conditions after construction shall also be considered in selection of proper sealing compounds and its application so that the sealing compound is able to withstand the stress and maintain its adhesive bond with the concrete. After allowing the concrete to dry, the sealing cavity shall be cleaned and exposed to atmosphere for some time till it is dry.

While applying compounds, the manufacturer's advice may be followed with regard to application of primer, if necessary. The application of primer shall be such as to cover the

sealing cavity to the full depth. No excess primer shall be applied. Sufficient time shall be allowed after the application of primer so that it dries completely before the application of sealing compound.

4.25. TOLERANCES IN CONCRETE SURFACES

Concrete surfaces for the various classes of unformed and formed finished specified in various Clauses shall comply with the tolerances shown in Table 9.11 hereunder, except where different tolerances are expressly required by the specification.

In Table 9.11 'line and level' and 'dimension' shall mean the lines, levels and cross-sectional dimensions as specified and required.

Surface irregularities shall be classified as 'abrupt' or 'gradual'. Abrupt irregularities include but shall not be limited to, offsets and fins caused by displaced or misplaced formwork, loose knots and other defects in formwork materials, and shall be tested by direct measurement. Gradual irregularities shall be tested by means of a straight template for plain surfaces or its suitable equivalent for curved surfaces, the template being 3 m long for unformed surfaces and 1.5 m long for formed surfaces.

TABLE 4.11

Class of Finish	Maximum tolerances 9mm) in :			
	Line and Level	Abrupt irregularity	Gradual irregularity	Dimension
U1	±12	6	±6	---
U2	±6	3	±3	---
U3	±6	3	±3	---
F1	±12	6	±6	+12 – 6
F2	±6	6	±6	+12 – 6
F3	±3	3	±6	+6

4.26. UNFORMED SURFACES - CLASS OF FINISH

Finishes to unformed surfaces of concrete shall be classified as U1, U2, U3, 'spaded" or 'bonded concrete'. Where the class of finish is not specified the concrete shall be finished to Class U1.

Where a bonded concrete surface is specified, the laitance shall be removed from the Class U1 finished surface and the aggregate exposed while the concrete is still green.

A spaded finish shall be a surface free from voids and brought to reasonably uniform appearance by the use of shovels as it is placed in the works.

Class U2 finish shall be a wood float finish. Floating shall be done after the initial set of the concrete has taken place and the surface had hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 finish shall be a hard smooth steel-trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface. The surfaces shall be trowelled under firm pressure and left free from trowel marks.

The addition of dry cement, mortar or water shall not be permitted during any of the above operations,

4.27. CURING, PROTECTING. REPAIRING & FINISHING

a) Curing

All concrete shall be cured by keeping it continuously damp for a period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, or ponded water, continuously saturated coverings of sacking, canvas, hessian or other absorbent materials, or approved effective curing compounds applied with spraying equipment capable of producing a smooth, even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

Certain types of finish or preparation for overlaying concrete must be done at certain stages of the curing process and special treatment maybe required for specific concrete surface finish.

Curing of concretes made of high alumina cement and super sulphated cement shall be carried out as directed by the Employer's Representative.

i) Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse 12 to 14 hours after laying concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin as soon as the concrete has hardened. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly a placed concrete.

ii) Continuous Spraying

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers, and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by the Employer's Representative.

iii) Alternate Curing Methods

Whenever in the opinion of the Employer's Representative, it is necessary to omit the continuous spray method, a covering of clean sand or other proved means such as wet gunny bags which will prevent loss of moisture from the concrete may be used. No

type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during the curing period.

For curing of concrete in pavements, sidewalks, floor, flat roofs or other level surfaces, the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Employer's Representative. Special attention shall be given to edges and comers of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

iv) Curing Compounds

Surface coating type curing compounds shall be used only by special permission of Employer's Representative. Curing compounds shall be liquid type white pigmented, conforming to U.S. Bureau of Reclamation specification. No curing compound shall be used on surfaces where future blending with concrete, water or acid proof membrane, or painting is specified.

v) Curing Equipment

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

b) Protecting Fresh Concrete

Fresh concrete shall be protected from defacements and damage due to construction operations by leaving forms in place for an ample period as specified later in these specifications. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by the Employer's Representative shall also be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion or contact with other materials etc., that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, the Employer's Representative may require that bridges be placed over the area.

c) Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defectives areas called for the attention of the Employer's Representative who may permit patching of the defective areas or also reject the concrete unit either partially or its entirely. Rejected concrete shall be removed and replaced by the Contractor. Holes left by form bolts etc., shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing 2,36 mm I.S. sieve shall be struck off flash at the fare of the concrete. Concrete surfaces shall be finished as described in specifications or as directed by the Employer's Representative.

Superficial honeycombed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of the Employer's Representativeand superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless

instructed otherwise by the Employer's Representative, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularities, care being taken to avoid damaging the surfaces. Surface irregularities shall be removed from grinding.

If reinforcement is exposed or the honeycombing occurs at vulnerable positions e.g. ends of beams or columns it may be necessary to cut out the member completely or in part and reconstruct. The decision of the Employer's Representative shall be final in this regard. If only patching is necessary, the defective concrete shall be cut out until solid concrete is reached or to a minimum depth of 25mm whichever is greater., the edges being cut perpendicular to the affected surface or with a small undercut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimeters beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

i) Use of Epoxy

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of the Employer's Representative. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

ii) Method of Repair

Small sizes holes having surface dimensions about equal to the depth of the hole, holes left after removal of from bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows. The hole to be patched shall be roughened and thoroughly soaked with clean water absorption stops.

A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly proud of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with Hessian. A steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportion as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

Mortar filling by air pressure (guniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for " ordinary cement, if so directed by the Employer's Representative, to match the shade of the patch with the original concrete. Also whereas as required for constinuation of reinforcement Hiliti can be used with prior approval of Employers representative.

iii) Curing of Patched Work

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray, or sprinkling for not less than 10 days. All fillings shall be lightly bonded to the concrete and shall be sound, free form shrinkage cracks after the fillings have been cured, and dried.

iv) Approval by the Employer's Representative

All materials, procedures and operations used in the repair of concrete and also the finished repair work shall be subject to the approval of the Employer's Representative.

d) Finishing

The type of finish for formed concrete surfaces shall be as follows, unless varied by the Employer's Representative.

When the structure is in service all the surfaces shall receive no special finish, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes left by form ties and rods and clean up of loose or adhering debris.
Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless a horizontal surface or the slope required is specified, the tops of narrow surfaces such as stair treads, walls curbs and parapets shall be sloped across the width approximately 1 in 30. Broader surfaces such as walkways, roads parking areas and platforms shall be sloped about 1 in 50.

Surfaces that will be covered by backfill or concrete, sub-floors to be covered with concrete topping, such as outside decks, floors of galleries and sumps, parapets, gutters, side-walks, floors and slabs, shall be consolidated, screeded and floated. Excess water and laitance shall be removed before final finishing. Floating may be done with hand or power tools and started as soon as the screeded surface has attained a stiffness to permit finishing operations and these shall be minimum required to produce a surface uniform in texture and free from screed marks or other imperfections. Joints and edges shall be tooled as specified or as directed by the Employer's Representative.

Finishes

Interior Wall:

All interior walls should be painted approved quality of distemper.

Exterior Wall:

The type of finishing & the color scheme of the external surfaces to be as preapproval of the Employer's Representative. However it shall be sand faced cement plaster in CM (1:4) 20 mm thick followed by water proofing cement based paint. This shall be of approved shade & brand to give even shade on the work in 3 or more coats.

i) Standard Finish for Exposed Concrete

Exposed concrete shall mean any concrete, other than floors or slabs, exposed to view upon completion of the works. Unless otherwise specified, the standard finish for exposed concrete shall be a smooth finish. A smooth finish shall be obtained with the

use of lined or plywood forms having smooth and even surfaces and edges. Panels of forms shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms the joint marks shall be smoothed off and all blemishes, projection, etc., removed leaving the surfaces smooth.

ii) Integral Cement Concrete Finish

When specified, an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified or directed by the Employer's Representative. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement finish to absorb moisture or to stiffen the mix.

iii) Rubbed Finish

A rubbed finish shall be provided only on exposed concrete surfaces. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and/ or damaged sections immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or rout after rubbing the finished surfaces shall present a uniform and smooth appearance.

e) Protection

The Employer's Representative shall protect all concrete against damage until final acceptance.

4.28. PREPARATION OF EARTH STRATA FOR FOUNDATION

a) General

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soil shall be removed and replaced with suitable earth well compacted or lean concrete as directed by the Employer's Representative. Where specified, lean concrete shall be provided on the earth stratum for receiving concrete. The surface of absorptive soils against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete and later shall help to cure the concrete.

b) Preparation of Concrete Surface

The preparation of concrete surfaces upon which additional concrete is to be placed later, shall preferably be done by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by the Employer's Representative. Great care shall be taken in performing this work to avoid removal of too much mortar the weakening of the surface by

loosening of aggregate. When it is not practicable to follow the above method, it will be necessary to employ air tools to remove laitance and roughen the surface.

The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

c) Bonding Treatment (Mortar)

After rock or concrete surfaces upon which new concrete is to be placed have been scarified, cleaned and wetted as specified herein, they shall receive a bonding treatment, immediately before placement of the concrete.

The bonding medium shall be a coat of cement-sand mortar shall have the same cement-sand proportions as the concrete which shall be placed on it. The water-cement ratio shall be determined by placing conditions and as approved by the Employer's Representative.

Bonding mortar shall be placed in sufficient quantity to completely cover the surface, about 10mm thick for rock surface and about 5mm thick for concrete surfaces. It shall be brushed or broomed over the surface and worked thoroughly in to all cracks, crevices and depressions. Accumulations or puddles or mortar shall not be allowed to settle on depressions and shall be brushed out to a satisfactory degree, as determined by the Employer's Representative.

Mortar shall be placed at such rate that it can be brushed over the surface just in advance of the placement of concrete. Only as much area shall be covered with mortar as can be covered with concrete before initial set in the mortar takes place. The amount of mortar that will be permitted to be place at any one time, or the area which it is to cover, shall be in accordance with the Employer's Representative's directions.

d) Cleaning and Bonding Formed Construction Joints.

Vertical construction joints shall be cleaned as specified above or by other methods approved by the Employer's Representative, hi placing concrete against formed construction joints, the surfaces of the joints, where accessible, shall be coated thoroughly with the specified bed-joint bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint by careful puddling and spading with the aid of vibrators and suitable tools.

e) Expansion and Contraction Joints

Provision shall be made for expansion and contraction in concrete by use of special type joints located wherever necessary and as shown on approved drawings.

4.29. HOT WEATHER REQUIREMENTS

All concrete work performed in hot weather shall be in accordance with IS: 456, except as herein modified.

Admixtures may be used only when approved by the Employer's Representative.

Adequate provisions shall be made to lower concrete temperatures by cool ingredients, eliminating excessive mixing, preventing exposure of mixers and conveyors to direct sunlight and the use of effective paint on mixers, etc. The temperature of the freshly placed concrete shall not be permitted to exceed 38°C.

Consideration shall be given to shading aggregate stockpiles from direct rays of the sun and spraying stockpiles with water, use of cold water when available, and burying, insulating, shading and/ or painting white the pipelines and water storage tanks and conveyances.

In order to reduce loss of mixing water, the aggregates, wooden forms, subgrade adjacent concrete and other moisture absorbing surfaces shall be well wetted prior to concreting. Placement and finishing shall be done as quickly as possible.

Extra precautions shall be taken for the protection and curing of concrete. Consideration shall be given to continuous water curing and protection against high temperatures and drying hot winds for a period of at least 7 days immediately after concrete has set and after which normal curing procedures may be resumed.

4.30. PLACING CONCRETE UNDERWATER

Under all ordinary conditions all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement underwater is necessary, all work shall conform to IS: 456 and the procedure shall be as follows:

i) Method of Placement

Concrete shall be deposited underwater by means of tremies, or drop bottom buckets of approved type.

ii) Discretion, Inspection and Approval

All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to the plans or specifications approved by the Employer's Representative.

4.31. PRECAST CONCRETE

a) General

Precast concrete units, whether manufactured on or off site, shall comply in every way with the provisions of the Contract for in situ concrete. Pre-cast units shall be hydraulically pressed or cast on vibrating table.

When ready for incorporation in the works, precast units shall be laid, bedded, jointed and fixed to the lines and levels as specified or required. Mortar for bedding and jointing shall consist of one part by volume of Portland cement and two parts by volume of natural sand or equivalent crusher fines.

All precast units shall be cast on a suitable bed or platform with firm foundation and free from wind. The Contractor shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.

b) Striking Form

Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

c) Precast Units

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place, Contractor shall satisfy the Employer's Representative or his representative that the methods he proposes to adopt for these operations will not over-stress or otherwise effect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.

d) Curing

All precast work shall be protected form the direct rays of the sun for at least 7 days after casting during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits.

4.32. PRECAST CONCRETE POROUS PIPES

Concrete porous pipes shall be made in accordance with IS: 4350. The pipes shall be of uniform cross section and bore and not more than 1 meter in length with minimum wall thickness of 50 mm with 1:3 cement to coarse aggregate proportion. The pipes shall have ogee or rebated joints, the axial length of which shall not be less than (D/36 + 12) mm, where D is the nominal internal diameter of the pipe in millimeters.

The wall thickness shall be such that the pipe shall bear a load of 20,000 N/m applied radially and have a porosity of not less than 0.65 D litres/metre/min.

4.33. SLOTS, OPENINGS, ETC.

Slots, openings or holes, pockets, etc., shall be provided in the concrete work in the approved positions or as directed by the Employer's Representative. Any deviation from the approved drawings shall be made good by Contractor at his own expense, without damaging and other work. Sleeves, bolts, inserts, etc., shall also be provided in concrete work where so required.

4.34. GROUTING

a) Standard Grout

Grout shall be provided as specified herein below.

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as follows:

TABLE 4.12

Use	Grout thickness	Mix Proportions	W/C ratio (max.)
i) Fluid mix	Under 25 mm	One part Portland cement to one part sand	0.44
ii) General	25 mm and over but less than 50 mm	One part Portland cement to two parts of sand	0.53
iii) Stiff mix	50 mm and over	One part Portland cement to three parts of sand	0.53

I. i) Sand shall be such as to produce a flowable grout without any tendency to segregate.

ii) Sand, for general grouting purposes, shall be graded within the following limits.

Passing IS 2.36 mm sieve	95 to 100%
Passing IS 1.18 mm sieve	65 to 95%
Passing IS 300 micron sieve	10 to 30%
Passing IS 150 micron sieve	3 to 10%

iii) Sand for fluid grouts, shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.

iv) Sand, for stiff grouts, shall meet the usual grading specifications for concrete,

II. i) Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.

ii) Anchor bolts, anchor bolt holes and the bottoms of equipment and column base plates shall be Cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted.

III. i) Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

ii) Water in anchor bolt holes shall be removed before grouting is started. Forms around base plates shall be reasonably tight to prevent leakage of the grout.

Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release trapped air, link chains can be used to work the grout into place.

Grout through holes in base plates shall be by pressure grouting.

Variations in grout mixes and procedures shall be permitted if approved by the Employer's Representative.

b) Non-Shrinking Grout for Equipment Foundation

Non-shrinking grout shall be used for grouting of machine base plates, anchor bolts, other anchoring devices and at locations where ordinary grouts are ineffective due to shrinkage. It shall be composed a type of expansive hydraulic setting binder and select-graded aggregates. It shall have properties as mentioned below :

1. Maximum grain size - 6
2. Water % (for 80% flow) - 15.17
3. Density of hardened Grout gm/ml - 2.27-2.30
4. Compressive strength N/mm2
   Min. 3 days - 23
   7 days - 34
   28 days - 45
5. Expansion, %
   Free - 0.15-0.2
   Restrained - 0.08-0.12

Mixing, batching, cleaning, preparation of surface and curing of non-shrinking grout shall be done as per Manufacturer's instructions.

4.35. INSPECTION

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of the Employer's Representative.

All materials supplied by the Contractor and all work or construction performed by the Contractor which is rejected as not being in conformity with the specifications and requirements, shall be immediately replaced.

Approvals of any preliminary materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying concrete and/or producing finished concrete in accordance with specifications and requirements.

All finished concrete shall be protected against damage until final acceptance by the Employer's Representative.

4.36. CLEAN-UP

Upon completion of the concrete work, all forms, equipment, construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.

All debris, i.e. containers, scrap wood, etc., shall be removed to "dump" daily, or as directed by the Employer's Representative.

The finished concrete surfaces shall be left in a clean condition satisfactory to the Employer's Representative

4.37. RECORDS OF CONCRETING

An accurate and upto date record showing times, dates, weather and temperature conditions when various positions of all the concrete structures forming the works were concreted will be kept by the Employer's Representativeshall be countersigned by the Contractor. If the Contractor fails to sigh the Employer's Representativerecord, it shall nevertheless be regarded as correct and binding on the Contractor.

4.38. FOUNDATION BEDDING, BONDING AND JOINTING

All surfaces upon or against which concrete will be placed, shall be suitably prepared by thoroughly cleaning, washing and dewatering, as specified or as the Employer's Representative may direct, to meet the various situations encountered in the work.

Soft or spongy areas shall be cleaned out and backfilled with either a soil-cement mixture, lean concrete or clean sand fill compacted to minimum density of 90% Modified Proctor.

Prior to construction of formwork for any item where soil act as bottom form, approval shall be obtained from the Employer's Representative as to the suitability of the soil.

4.39. DEWATERING

Dewatering is process of removal of water from a foundation pit when it is situated below the ground water table or when it is surrounded by a cofferdam. The purpose of dewatering is to keep the excavation dry so that concreting can be done. Dewatering is temporary if it is done at the time of construction. It is followed by restoration to its original water table after the structure has been be completed. Dewatering may be done by sump and pump, but for deep excavtions such as in case of intake pump house, treated water sumps etc. Wellpoint systems are advised. Well points are either with braces or stainless steel screens and are made with either closed ends or self jetting types and spacing of the well points depends on the permeability of the soil and on the availability of the time to affect the drawdown. Further specially in case of intake pump house, being quite deep the well points must be installed in two or more stages and on the other hand, it is possible to avoid multi-well point stages by excavating don to water level before installing the pump and header or deep weel drainsge shall be used for dewatering.

4.40. PREPARATION OF ROCK STRATA FOR FOUNDATIONS

To provide tight bond with rock foundations, the rock surface shall be prepared and the following general requirements shall be observed.

Concrete shall not be deposited on large sloping rock surfaces. Where required by the Employer's Representative, the rock shall he cut to form rough steps or benches to provide roughness or a more suitable bearing surface.

Rock foundation stratum shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unsheltered condition.

Shortly before concrete is placed, the rock surface shall be cleaned with high pressure water and air jet even though it may have been previously cleaned in that manner.

Prior to placing concrete, the rock surface shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Employer's Representative.

Before placing concrete on rock surfaces all water shall be removed from depressions to permit through inspection and proper bonding of the concrete to the rock.

4.41. FORMWORK

4.41.1. FORMWORK - FIXING AND GENERAL

All formwork shall be constructed of timber, sheet metal or other approved material. It shall be firmly supported adequately strutted, braced and tied to withstand the placing and vibrating of concrete and the effects of weather. The tolerance on line and level shall not exceed 3 mm and the soffit of beams other than pre-stressed beams shall be in the absence of any specified camber, be erected with an upward camber of 6 mm for each 3 metres of span.

The Contractor shall be responsible for the calculations and design for the formwork, and if required, shall submit them to the Employer's Representative for approval before construction. On formwork to external faces, which will be permanently exposed, all horizontal and vertical formwork joints shall be so arranged that Joint lines will form a uniform pattern on the face of the concrete. Where the Contractor proposes to make up the formwork from standard sized manufactured formwork panels, the Employer's Representative shall approve the size of such panels before they are used in the construction of the works. The finished appearance of the entire elevation of the structure and adjoining structures shall be considered when planning the pattern of joint lines caused by formwork and by construction joint to ensure continuity of horizontal and vertical lines.

Faces of formwork in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, splits or other defects, and all formwork shall be clean and free from standing water, dirt, shavings, chipping or other foreign matter. Joints shall be sufficiently watertight to prevent the escape or mortar or the formation of fine and other blemishes on the face of the concrete.

Formwork shall be provided for the top surfaces of sloping work where the slope exceeds fifteen degrees from the horizontal (except where such top surface is specified as spaded

finish) and shall be anchored to enable the concrete to be properly compacted and to prevent floatation, care being taken to prevent air being trapped.
Openings for inspection of the inside of the formwork and for the removal of water used for washing down shall be provided and so formed to be easily closed before placing concrete. Before placing concrete, all bolts, pipes or conduits or other fixtures which are to be built in shall be fixed in their correct positions, and cores and other devices for forming holes shall be held fast by fixing to the formwork or otherwise. Holes shall not cut in any concrete without approval of the Employer's Representative.

All exterior angles on the finished concrete of 90° or less shall be given 20 mm x 20 mm chamfers unless otherwise ordered by the Employer's Representative.

No ties or bolts or other device shall be built into the concrete for the purpose of supporting formwork without the prior approval of the Employer's Representative. The whole part of any such supports shall be capable of removal so that no part remaining embedded in the concrete shall be nearer than 50 mm from the surface in the case of reinforced concrete and 150 mm in the case of un-reinforced concrete. Holes left after removal of such supports shall be neatly filled with well-rammed dry-pack mortar (Clause 9.135).

Formwork in contact with the concrete shall be treated with a suitable non-staining mould oil to prevent adherence of the concrete except where the surface is subsequently to be rendered. Care shall be taken to prevent the oil from coming in contact with reinforcement or with concrete at construction joints. Surface retarding agents shall be used only where ordered by the Employer's Representative.

4.41.2. REMOVAL OF FORMWORK

Formwork shall be so designed as to permit any removal without resorting to hammering or levering against the surface of the concrete. The periods of time elapsing between the placing of the concrete and the striking of the formwork shall be as approved by the Employer's Representative after consideration of the loads likely to be imposed on the concrete and shall in any case be not less than the periods shown in Table 9.13 below. Where soffit formwork is constructed in a manner during and after such removal of a sufficient number of adequate supporting props in an undisturbed condition, the Contractor may with the agreement of the Employer's Representative, remove the formwork at the earlier times listed below provided that the props are left in position.

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to arises and projections and without shock or vibration, by gently easing the wedges. If after removing the formwork it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

TABLE 4.13

Position of Formwork	Days for Striking
Walls	1
Side of beams and columns	2
Slabs (Props left under)	3
Props to slabs (span not exceeding 4.5 m)	7
Props to slabs (span exceeding 4.5 m)	14
Beams soffit (props left under)	7
Props to beams (span not exceeding 6 m)	14
Props to beams (span exceeding 6 m)	21

Notwithstanding the foregoing, the Contractor shall be held responsible for any damage arising from removal of formwork before the structure is capable of carrying its own weight and any incidental loading.

Striking shall be done slowly with utmost care to avoid damage to arises and projections and without shock or vibration, by gently easing the wedges. If after removing the formwork it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

Reinforced temporary openings shall be provided, as directed by the Employer's Representative, to facilitate removal of formwork which otherwise may be inaccessible.

Tie rods, clamps, form bolts etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours nor later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of the walls and grade beams will not be permitted.

For liquid retaining structures no sleeves for through bolts shall be used nor shall through bolts be removed as indicated above. The bolts, in this case, shall be cut at 25 mm depth or more from the surface and then the hole shall be made good by cement sand mortar of the same proportions as the concrete just after striking the formwork.

4.41.3. FORMED SURFACES - CLASSES OF FINISH

Finishes to form surfaces of concrete shall be classified as Fl, F2 or F3 or such other special finish as may be particularly specified. Where the class of finish is not specified the concrete shall be finished to Class Fl.

Formwork for Class F3 finish shall be lined with as large panels as possible of non staining material with a smooth unblemished surface such as sanded plywood or hard compressed

fibre board, arranged in uniform approved pattern and fixed to back formwork by oval nails. Un-faced wrought boarding or standard steel panels shall not be permitted.

Formwork for Class F2 finish shall be faced with wrought tongued and grooved boards or plywood or metal panels arranged in a uniform approved pattern free from defects likely to detract from the appearance of the surface.

Formwork for Class FI finish shall be constructed in timber, sheet metal or any suitable materials, which will prevent loss of grout when the concrete is vibrated. Surfaces subsequently to be rendered, plastered and tiled shall be adequately scabbed or hacked as soon as the formwork is removed to reduce the irregularities to not more than half the thickness of such rendering, plastering or bedding for tiles and to provide a satisfactory key.

4.41.4. DEFECTS IN FORMED SURFACES

Workmanship in formwork and concreting shall be such that concrete shall normally require no making good, surface being properly compacted and smooth.

If any blemishes are revealed after removal of formwork, the Employer’s Representative's decisions concerning remedial measures shall be obtained immediately. These measures may include, but shall not be limited to the following:

Fins, pinhole bubbles, surface discolouration and minor defects may be rubbed down with sacking immediately after the formwork is removed.

Abrupt and gradual irregularities may be rubbed down with carborundum and water after the concrete has been fully cured. These and any other defects shall be remedied by methods approved by the Employer’s Representativewhich may include using a suitable epoxy resin or, where necessary, cutting out to a regular dovetailed shape at feast 75 mm deep and refilling with concrete over steel mesh reinforcement sprung into the dovetail.

4.41.5. HOLES TO BE FILLED

Holes formed in concrete surfaces by formwork supports or the like shall be filled with dry-pack mortar made from one part by weight of ordinary Portland cement and three parts fine aggregate passing IS sieve 1.18 mm. The mortar shall be mixed with only sufficient water to make the materials stick together when being moulded in the hands.

The Contractor shall thoroughly clean any hole that is to be filled with dry-pack mortar and where the surface has been damaged the Contractor shall break out any loose, broken or cracked concrete or aggregate. The concrete surrounding the hole shall then be thoroughly soaked after which the surface shall be dried so as to leave a small amount of free water on the surface. The surface shall then be dusted lightly with ordinary Portland cement by means of a small dry brush until the whole surface that will come into contact

with the dry-pack mortar has been covered and darkened by absorption of the free water by the cement Any dry cement in the hole shall be removed.

The dry-pack material shall then be placed and packed in layers having a compacted thickness not greater than 15 mm. The compaction shall be carried out by use of a hardwood stick and a hammer and shall extend over the full area of the layer, particular care being taken to compact the dry-pack against the sides of the hole. After compaction the surface of each layer shall be scratched before further loose material is added. The hole shall be finished by laying a hardwood block against the dry-pack fill and striking the block several times. Steel finishing tools shall not be used and water shall not be added to facilitate finishing.

4.42. TOLERANCES

Tolerances is a specified permissible variation from lines, grade or dimensions given in approved drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted:

Tolerances for R.C. Building

i) Variation from the plumb -

a) In the lines and surfaces of columns, piers, walls and in arises

5 mm per 2.5 m or 25 mm, whichever is less.

b) For exposed comer columns and other conspicuous lines —

In any bay or 5 m maximum - 5 mm

In 10m or more - 10 mm

ii) Variation from the level or from the grades indicated on the approved drawings.

a) In slab soffit, ceilings, beam soffit, and in shard edges

In 2.5m 5 - 5mm

In any bay or 5 m maximum - 10 mm

In 10 m or more - 15mm

b) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines-

In any bay or 5 m maximum - 5 mm

In 10 m or more - 10 mm

iii) Variation of the linear building lines from established position in plan and related position of columns, wall and partitions.

In any bay or 5 m maximum - 10 mm

In 10 m or more - 20 mm

iv) Variation in the sizes and locations of sleeves, openings in walls and floors 5 mm except in the case of and for anchor bolts

v) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus - 5 mm

Plus - 10 mm

vi) Footings

a) Variation in dimension in plan

Minus - 5 mm

Plus - 50mm

b) Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm

c) Reduction in thickness

Minus - 5% of specified thickness subject to a maximum of 50mm

vii) Variation in steps -

a) In a flight of stairs

Rise - 3 mm

Tread - 5 mm

b) In consecutive steps

Rise - 1.5mm

Tread - 3 mm

Tolerances in other concrete structures

i) All structures

a) Variation of the constructed linear outline from established position in plan

In 5 m - 10 mm

In 10 m or more - 15 mm

b) Variation of dimensions to individual structural features from established positions -

In 20 m or more - 25 mm

In buried construction - 50 mm

c) Variation from plumb, from specified batter or from curved surfaces of all structures

In 2.5 m - 10 mm

In 5 m - 15 mm

In 10 m or more - 25 mm

In buried construction - Twice the above amounts

d) Variation from level or grade indicated on approved drawings in slab, beams, soffit, horizontal grooves and visible arises -

In 2.5 m - 5 mm

Ln 7.5 m or more - 10 mm

In buried construction - Twice the above amounts

e) Variation in cross-sectional dimensions of columns, beams.buttresses, piers and similar members -

Minus - 5 mm

Plus - 10 mm

f) Variation in the thickness of slabs, walls, arm sections and similar members -

Minus - 5 mm

Plus - 10 mm

ii) Footings for columns, piers, walls, buttresses and similar members

a) Variation of dimensions in plan -

Minus - 10 mm

Plus - 50 mm

b) Misplacement or electricity -

2% of footing width in the direction of misplacement but not more than 50 mm

c) Reduction in thickness -

5% of specified thickness subject to a maximum of 50 mm

iii) Tolerances in other types of structures shall generally conform to those given in Clause 2.4 of Recommended Practice for Concrete Formwork (American Concrete Institute -Ad 347)

iv) Tolerances in fixing anchor bolts shall be as follows:

a) Anchor bolts without sleeves ±5 mm,

b) Anchor bolts with sleeves ± 5.0 mm for bolts upto 3.00 mm for bolts above 32 mm dia

c) Embedded parts ± 5 mm in all direction.

4.43. BRACINGS, STRUTS AND DROPS

Formwork shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due top the movement of men and other materials. Bamboos shall not be used as proper cross bearers.

The formwork for beams and slabs shall be so erected that the formwork on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Re-propping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the formwork.

If the formwork for a column is erected for the full height of the column, one side shall be left open and built up in sections as placing of the concrete proceeds, or windows may be left for pouring concrete from the sides to limit he drop of concrete to 1.0 m or as directed by the Employer's Representative.

4.44. REINFORCEMENT

4.44.1. GENERAL

Reinforcement shall be TMT deformed bars (Thermo Mechanical Treatment) Fe 500 as per IS: 1786. Wire mesh or fabric shall be in accordance with IS: 1566. Substitution of reinforcement will not be permitted.SHALL BE ONLY PROCURED from list of makes as per Section-X, Volume-2 Employers Requirement, using iron ore as the basic raw material and having an in house iron making facilities followed by production of liquid steel and crude steel with in house rolling.adopting BF-BOF route or DRI-EAF technology as per Ministry of Steel Government of India Guildlines. No re-rolled material/secondary steel will be acepted or allowed for any structural steel. As per Is 1786 :2008 under clause 4.2.3 Low alloyed/microalloyed/CRS steel can also be used by adding alloy elements like Cu,Cr,Ni, Mo and P either individually or in combination to improve allied product propoerties.however, the total content of these elements shall not be less than 0.40%.in such alloys when phosphorous is used, it shall not exceed 0.12%and the carabon shall be restiricted to max. 0.15%.Every lot shall be accompined by the manufactures certificate certifying the quality, grade and material and shall be tested in an independent laboratory to certify all propoerties as per IS 1786 and shall be TMT/CRS.

4.44.2. STORAGE

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like.

If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/ or be kept under cover or stored as directed by the Employer's Representative.

Fabricated reinforcement shall be carefully stored lo prevent damage, distortion corrosion and deterioration.

4.44.3. QUALITY

All steel shall be of Grade I quality unless specifically permitted by the Employer's Representative. No re-rolled material will be accepted. If requested by the Employer's Representative, the Contractor shall submit the manufacturer's test certificate for the steel. Random tests on steel supplied by the Contractor may be performed by the Employer's Representativeas per relevant Indian Standards. All costs incidental to such test shall be at the Contractor's expense. Steel not conforming to specifications shall be rejected.

All reinforcements shall be clean, free from grease, oil, paint, dirt, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. No welding of rods to obtain continuity shall be allowed unless approved by the Employer's Representative. If welding is approved, the work shall be carried out as per IS: 2751 according to the best modem practices and as directed by the Employer's Representative, in all cases of important connections, test shall be made to prove that the joints are of full strength of bars welded. Special precautions, as specified by the Employer's Representative, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

4.44.4. LAPS

Laps and splices for reinforcement shall be 50 time the diameter of such reinforcement. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the approved drawings, shall be approved by the Employer's Representative. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

4.44.5. BENDING

Reinforcing bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done cold and without damaging the bars.

All bars shall be accurately bent according to the sizes and shapes shown on the approved details working drawings/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and rebent in a manner that will injure the material, bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25mm in diameter which may be bent hot if specifically approved by the Employer's Representative. Bars which depend for their strength on cold working, shall not be bent hot. Bars bent hot shall not be treated beyond cherry red colour (nor exceeding 845°C) and after bending shall not be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and rebending be such as shall not, in the opinion of the Employer's Representative, injure the material. No reinforcement shall be bent when in position the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those require by design shall not be used.

4.44.6. FIXING

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the approved drawings by the use of blocks, spacers and chairs, as per IS: 2502, to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with number 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

4.44.7. COVER

Nominal cover shall be as per IS 456 – Table 16.

Increased cover thickness shall be provided for surfaces exposed to the action of harmful chemicals or exposed to earth contaminated by such chemicals, acid, alkalis, saline atmosphere, sulphurous smoke etc. and such increase of cover may be between 15 mm and 50 mm beyond the figures mentioned here as may be specified by the Employer's Representative.

The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on sub-grade shall be supported on precast concrete blocks as approved by the Employer's Representative. The use of pebbles or stones shall not be permitted.

The 28 days crushing strength of cement mortar cubes/ precast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/ blocks are embedded.

The minimum clear distance between reinforcing bars shall be 50 mm.

4.44.8. INSPECTION

Erection and secured reinforcement shall be inspected and approved by the Employer's Representative prior to placement of concrete.

4.44.9. WELDING OF REINFORCEMENT

Reinforcement which is specified to be welded shall be welded by an process which conforms with the Requirements of IS: 2751 and which the Contractor can demonstrate by bend and tensile tests will ensure that the strength of the parent metal is not reduced and that the weld possesses a strength not less than that of the parent metal. The welding procedure established by successful test welds shall be maintained and no departure from this procedure shall be permitted.

Weld in positions other than those shown on the approved drawings shall not be permitted. Tack welding lightly secure reinforcement in place will be permitted subject to approval of the Employer's Representative.

4.44.10. SUPPLY OF REINFORCING BARS

Steel reinforcement, such as M.S. bars high yield strength deformed bars etc. required for the works shall be procured by Contractor. The Contractor shall arrange for transport, loading, unloading and storage at the work sites. The Contractor should plan the procurement of steel in such a way that at least required quantity of steel of specified sizes is available at site for 3 months period.

Steel brought on site shall be stored in a proper manner as approved by the Employer's Representativeso as to avoid distortion, deterioration and corrosion. The Contractor shall maintain proper registers for the steel account, showing the steel received at site, steel used, and the balance stock on site, to the entire satisfaction of the Employer's Representative.

4.58 ROADWAYS

4.58.1. SCOPE

a) This specification covers the furnishing of all materials, plant, labour, equipment, tools and services for the complete and proper construction of approach roads and cross drainage works as specified herein and shown on the drawings including all surveying and setting out necessary for the same and clean up of working areas.

b) This specification covers the materials and construction of only water-bound macadam roads with bituminous surfacing treatments as shown on the drawings or as directed by the Employer's Representative, including all the necessary earthwork for the same.

4.58.2. MATERIALS

a) General

All materials shall be obtained from local sources and shall be subject to approval by the Employer's Representativeprior to use. Substitution of material shall be on and "Approved equal" basis as determined by the Employer's Representativeand shall result in finished roads as designated in this specification and at no additional cost to the Employer. Material aggregates shall consist of natural or crushed stone, gravel or sans, shall be of reasonably uniform quality throughout, and shall be clean and free from soft or decomposed particles, excess clay, foreign, organic, or other deleterious matter.

b) Materials for Embankment

Murrum to be used for making the road embankment shall be obtained from approved borrow areas of weathered disintegrated basalt. It shall contain silicious material. The murrum shall be dry friable, and free from clay and plastic materials, mud, sludges, vegetable matter or rotten material of any kind. The size of murrum lump shall not be more than 20 mm.

c) Coarse Aggregate for Sub-Base. Base and Semigrout

Coarse aggregate shall be crushed or broken stone and shall conform to the physical requirement given in Table 4.14.

TABLE 4.14

Physical requirements of Crushed Stone for Road Work

Sr. No.	Test	Limiting Value	
		For aggregates to be used for Road base and surfacing	For aggregate to be used for sub-grade
1.	Specific Gravity	Not less than 2.6	Not less than 2.0
2.	Water Absorption	Not more than 2%	Not less than 5%
3.	Flakiness Index	Maximum 25%	----
4.	Elongation Index	Maximum 40%	----
5.	Aggregate impact value or Aggregate Crushing Value	Not more than 30%	Not more than 40%
6.	Los Angeles Abrasion Value	Not more than 30%	Not more than 50%
7.	Stripping Test	Maximum 15%	----

The crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter. Crushed or broken stone shall conform to the grading given in Table 4.15

TABLE 4.15

Grading No.	Size Range	IS. Sieve Designations	Percent by Weight passing the sieve
3.	50 mm to 20 mm	63 mm	100
		50 mm	95 - 100
		40 mm	35 - 70
		20 mm	0 - 10
		10 mm	0 - 5

d) Screenings

Screenings shall consist of predominantly non-plastic materials such as sandy gravely murrum or gravel (other than rounded river borne material) with Liquid Limit and Plasticity Index below 20 and 6 respectively and fraction passing 75 micron sieve not exceeding 10%. The materials shall be sound and hard, of a quality not affected by weather and shall be screened at the quarry and shall be free from all impurities. Any large lumps of murrum shall be broken to pass gradation given in Table 4.16. Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt and impurities.

Screenings shall conform to the grading indicated in Table 4.16.

TABLE 4.16

Grading Classification	Size of Screenings	IS. Sieve Designations	Percent by Weight passing the sieve
A.	12.5 mm	12.5 mm	100
		10.0 mm	90 – 100
		4.75 mm	10 – 30
		150 microns	0 – 8
B.	10.0 mm	10.0 mm	100
		4.75 mm	85 – 100
		150 microns	10 – 30
		75 microns	0 – 10

e) Blindage Material

To fill in the voids in the coarse aggregates, any non-plastic material such as gravel/ grit/ state dust/ sand/ brick powder may be used. The plasticity index of the material shall not exceed six.

f) Binder

The binder shall be straight run Bitumen of grade S35 or S65 and shall conform to the requirements specified in Table 4.17

TABLE 4.17

Sr.No.	Characteristic	Requirement of Grade		Method of Test Reference to
		S35	S65	
1.	Specific gravity at 27^0C Min.	0.99	0.99	IS : 1202
2.	Water prevent by weight. Max	0.2	0.2	IS : 1211
3.	Flash point. Pensky Martens closed type ^{0}C. Min.	175	175	IS : 1209 (Method A)
4.	Seftening point, ^{0}C	50 – 65	40 – 55	IS : 1205
5.	Penetration, at 25^0C , 100g, 5 sec in 1/100 m	30 – 40	60 – 70	IS : 1203
6.	Ductility at 20^0C in cm, Min	50	75	IS : 1208
7(a)	Loss on beating, percent by weight, Max.	1	1	IS : 1212
(b)	Penetration of residue (expressed as percentage of item 5), Min	60	60	IS : 1203
8.	Matter soluble in carbon disulphide, percent by weight, Min.	99	99	IS : 1216

4.58.3. SETTING OUT

The Contractor shall provide all labour and materials such as line, strings, pegs, nails, bamboos, stones, mortar, concrete etc., required for setting out, establishing benchmarks and giving profiles. The Contractor shall be responsible for maintaining the benchmarks, profiles, alignment and other stakes and marks as long as they are required for the work in the opinion of the Employer's Representative.

4.58.4. EARTHWORK

a) Earthwork in Excavation

Profiles of road excavation shall be laid at 50 m intervals to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked. The Contractor shall on no account excavate beyond the slopes or below the specified grade unless so directed by the Employer's Representativein writing. If excavation is done below the specified level or outside the section it shall not be paid for and the Contractor shall be required to fill up such extra excavation with approved materials, in layers of 150 mm to 200 mm, watered and compacted as specified for the sub-grade. The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections, and side slopes as specified in the drawings or directed by the Employer's Representative.

b) Earthwork in Embankment Stripping

The entire area to be occupied by the embankment, shall be stripped to a sufficient depth, as determined by the Employer's Representative to remove all materials unsuitable and objectionable for incorporation in embankment. All excavations below the ground level arising out of the removal of trees, stumps, etc. shall be filled with suitable material and compacted thoroughly all as specified for the embankment fill material, so as to make the surface at these points conform to the surrounding area.

4.58.5. PREPARATION OF SUB-GRADE

Immediately prior to the laying of the sub-base metal, the sub-grade shall be cleaned of all foreign substances, vegetation etc. Any ruts or soft yielding patches that appear shall be corrected and the sub-grade dressed off parallel to the finished profile. The camber of sub-grade shall conform in shape to that of the finished road surface. Camber boards shall be used to get the required section. The prepared sub-grade shall be lightly sprinkled with water, if necessary and rolled with a power roller of 10-12 tonnes. The roller shall pass over the same area of the sub-grade a minimum of five runs. Any undulations in the surface that develop due to rolling shall be made good with approved earth and sub-grade re-rolled.

4.58.6. SUB-BASE

a) General

The sub-base shall not be constructed on a wet sub-grade. The width of the sub-base course shall be 150 mm more on either side than that of the water bound macadam wearing course. The finished thickness of the sub-base course shall be 160 mm. The sub-base metal course shall be laid in 2 layers, each of thickness 120 mm and finished to 80mm.

b) Spreading and Rolling

The metal shall be spread uniformly and evenly upon the prepared base to a thickness of 120 mm. The spreading shall be done from stock piles along the side of the roadway. In no case shall the aggregates be dumped in heaps directly on the surface prepared to receive the metal nor shall hauling over an un-compacted or partially compacted base be permitted. The surface of the aggregate shall be carefully checked, with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradations with no pockets of fine material. Immediately

following the spreading of the metal, rolling shall be started with three wheeled power rollers of 10 to 12 tonnes capacity or tandem or vibratory rollers of approved type. Rolling shall begin from the edges gradually progressing towards the centre. First the edge/ edges shall be firmly compacted with roller running forward and backward. The roller shall then move inwards parallel to the center-line of the road, in successive passes uniformly lapping preceding tracks by at least one half width. Rolling shall be continued until the road metal has been thoroughly keyed and forward movement of stones ahead of the roller is no longer visible. Slight sprinkling of water may be done if necessary.

c) Application of Screening

After the metal has been thoroughly keyed and set by rolling, screening to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screening is being spread so that vibrations of the roller cause them to settle in the voids. The screenings shall not be dumped in piles but be spread uniformly by spreading motion of hand shovels. The dry rolling now shall be accompanied with brooming with hand brooms, wire brushes or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent tilling of voids or prevent the direct bearing of the roller on the metal. These operations shall continue until no more screenings can be forced into the voids in the metal.

d) Sprinkling and Grouting

The surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary, until the coarse aggregate has become well bonded and firmly set in its full depth and a grout has been formed of the screenings. Care shall be taken to see that the underlying layers do not get damaged due to the addition of excessive quantities of water during construction. After the first layer of the sub-base has fully set, to the satisfaction of the Employer's Representative, the second layer shall be laid. The constructional operation for the second layer will be the same as that specified herein for the first.

4.59. Roadways, Pathways & Hardstandings

A comprehensive network of roadways shall be provided around the treatment plant to link in with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access. All roads shall be minimum 5 meters wide. Vehicular access shall be provided for all Plant structures and buildings. All roads shall be provided with drainage and shall be constructed to prevent standing water.

Paved pedestrian access ways shall be constructed to provide a network of logical routes interlinking plant areas. Damage to any existing roads on account of their use by the Contractor shall be made good to the satisfaction of the Employers Representative.

Hardstanding areas shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The

road system shall be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again without the need to reverse or carryout complicated maneuvers in order to exit the site.

Any structure or pipeline crossing below roads shall be designed for Class 'A' of IRC loading.

All roads shall be of asphalt macadam/ concrete and all strengthing of road required for plant entry is in scope of the Conatrctor.

4.59.1. EMABANKMENT CONSTRUCTION

General

These Specifications shall apply to the construction of embankments including sub-grades, earthen shoulders and miscellaneous backfills with approved material obtained from approved source, including material from roadway and drain excavation, borrow pits or other sources. All embankments sub-grades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections or as directed by the Employers representative.

Density Requirements of Embankment and Sub-grade Materials

Condition of Embankment	Type of Work Maximum laboratory dry unit weight when tested as per IS:2720 (Part 8)
Embankments up to 3 m height, not subjected to extensive flooding	Not less than 16 kN/cu.m
Embankments exceeding 3 m height or embankments of any height subject to long periods of inundation	Not less than 17 kN/ cu.m
Sub grade and earthen shoulders/verges/ backfill	Not less than 18 kN/cu.m

Compaction Requirements for Embankment and Sub-grade

Type of work/material	Relative compaction as percentage of max. laboratory dry density as per IS:2720 (Part 8)	Minimum CBR %
Sub grade and earthen shoulders	Not less than 98%	5
Embankment	Not less than 97%	5
Expansive Clays a) Sub grade and 500 mm portion just below the sub-grade	Not allowed Not less than 90%	- 4

b) Remaining portion of embankment		

Granular sub Base

Construction of Granular Sub-Base by providing close graded material, spreading in uniform layers with motor grader on prepared surface, mixing by Mix In Place Method with rotavator at OMC, and compacting with vibratory roller to achieve the desired density.

Scope

This work shall consist of laying and compacting well-graded material on prepared sub grade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Employers representative.

Materials

The material to be used for the work shall be natural sand, crushed gravel, crushed stone, or combination thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and shall conform to the quality standards as prescribed in the specifications.

Table 400-1 of MORTH prescribes four gradings for Granular Sub-Base (GSB). Gradings I and II in Table 400-1 are well graded granular sub-base materials. These can be used at locations where drainage requirement are not predominant. Gradings III and IV are gap graded and addresses to the concern of the drainage requirements. These can be used at location experiencing heavy rainfall, flooding etc. Cases where GSB is to be provided in two layers, it is recommended to adopt either grading III or grading IV for lower layer and either grading I or grading II for upper layer. Minimum thickness of lower layer at locations where drainage requirements are predominant shall not be less than 200 mm.

Physical requirements: The material shall have a 10 percent fines value of 50kN or more (for sample in soaked condition) when tested in compliance with IS:2386 (Part IV) 1963. The water absorption value of the coarse aggregate shall be determined as per IS:2386 (Part 3). If this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:383. For Gradings II and IV materials, the CBR shall be determined at the density and moisture content likely to be developed in the field.

Strength of Sub-Base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished. When directed by the Employers representative, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content.

Table : Grading for Granular Sub-base Materials

IS Sieve Designation	Percent by weight passing the IS sieve			
	Grading I	Grading II	Grading III	Grading IV
75.0 mm	100	—	100	—
53.0 mm	80-100	100	100	
26.5 mm	55 –90	70-100	55-75	50-80
9.50 mm	35-65	50-80		
4.75 mm	25 – 55	40-65	10-30	15-35
2.36 mm	20- 40	30-50		
0.425 mm	10-15	10- 15		
0.075 mm	<5	< 5	< 5	< 5
CBR Value (Minimum)	30	25	30	25

Wet Mix Macadam -

Providing, laying, spreading and compacting crushed graded stone aggregate as per Table 400-10 & 400.11 to Wet Mix Macadam specifications of MORTH including premixing the material with water to OMC in mechanical mixer (Pug mill) as per design mix, carriage of mixed material by tipper to site laying in uniform layers, with motor grader/F.E. loader/Paver Finisher, in sub-base/base course on a well prepared under-base and compacting with Vibratory Roller to achieve the desired density including lighting, guarding, barricading and maintenance of diversion etc. (MoRTH specification : Clause 406).

WET MIX MACADAM SUB-BASE/BASE

Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-grade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Employers representative.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be upto 200 mm with the approval of the Employers representative Refer below clause of MORTH

406.2 Materials

406.2.1 Aggregates

406.2.1.1 Physical requirements :

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 percent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-9 of MORTH. If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part-5).

Grading requirements: The aggregates shall conform to the grading given in Table 400-10 of MORTH.

Table: Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-base/Base Courses

S. No.	Test	Test Method	Requirements
1.	Los Angeles Abrasion value	IS:2386 (Part-4)	40 percent (Max.)
	Aggregate Impact value	IS:2386 (Part-4) or IS:5640	30 percent (Max.)
2.	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	40 percent (Max.)*

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles are separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

Table : Grading Requirements of Aggregates for Wet Mix Macadam

IS Sieve Designation	Per cent by weight passing the IS Sieve	
	Grade 1 layer thickness ≥ 100mm	Grade 2<100 mm
53.00 mm	100	
45.00 mm	95 – 100	
26.50 mm	–	100
22.40 mm	60 – 80	50-100
11.20 mm	40 – 60	-
4.75 mm	25 – 40	35-55
2.36 mm	15 – 30	-
600.00 micron	8 – 22	10-30
75.00 micron	0 – -5	2-5

Primer coat

Providing and applying Primer coat with bitumen emulsion on prepared surface of granular Base including clearing of road surface and spraying primer at the rate of 0.60 kg/sqm using mechanical means.

MoRTH Clause 502 - PRIME COAT OVER GRANULAR BASE

Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

Materials

The bituminous material to be used as primer shall be such that it can penetrate about 10 mm deep into base course. Bitumen emulsion SS1 grade conforming to IS:8887/ASTM D2397 or medium curing cutback bitumen conforming to IS:2177 can be used as primer. Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as per Table 500-1of MORTH as below:

Table : Quantity of Bitumen Emulsion for Various Types of Granular Surface

Type of Surface	Rate of Spray (kg/sq.m)
WMM/WBM	0.7–1.0
Mechanically lime/cement stabilized soil bases, lime cement bases	0.9–1.2
Gravel bases, Crusher run Macadam and crushed rock bases	1.2–1.5

Tack Coat

Providing and applying tack coat using bitumen emulsion conforming to IS: 8887, using emulsion pressure distributer including preparing the surface & cleaning with mechanical broom. On bituminous surface @ 0.25 kg/ sqm.

MoRTH Clause 503 TACK COAT

Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or instructed by the Employers representative.

Materials

The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with IS 8887/ASTM D 2397 or suitable low viscosity paving bitumen of VG 10 grade conforming to IS:73. The use of cutback bitumen RC:70 as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Employers representative. The type and grade of tack coat shall be as specified in the Contract or as directed by the Employers representative.

Dense graded bituminous macadam

Providing and laying Dense graded bituminous macadam with 100-120 TPH batch type HMP producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with VG-30 grade of bitumen @ 4-4.25% by weight of total mixture and filler, transporting the hot mix to work site, laying with a hydrostatic paver

finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MoRTH specification clause No. 505 complete in all respects:Grade-1

MoRTH Clause 505 - DENSE GRADED BITUMINOUS MACADAM

Scope

This clause specified the construction of Dense Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. The work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

Materials

Bitumen : The bitumen for dense bituminous macadam shall comply with the Indian Standard Specification for viscosity graded bitumen, IS:73 modified bitumen complying with IS:15462 or as otherwise specified in the Contract. Guidelines for selection of viscosity graded bitumen and modified bitumen are given in Table 500-5 and Table 500-6 of MORTH respectively.

Table Selection Criteria for Viscosity-graded (VG) Paving Bitumens Based on Climatic Conditions

	Highest Daily Mean Air Temperature, °C		
Lowest Daily Mean Air Temperature, °C	Less than 20°C	20 to 30°C	More than 30°C
More than –10°C	VG-10	VG-20	VG-30
-10°C or lower	VG-10	VG-10	VG-20

Table Selection Criteria for Grade of Modified Bitumen

Lowest Daily Mean Air Temperature, °C	Highest Daily Mean Air Temperature, °C		
	Less than 20°C	20 to 30°C	More than 30°C
	Grade of Modified Bitumen		
More than -10°C	PMB/NRMB 120 CRMB 50	PMB/NRMB 70 CRMB 55	PMB/NRMB 40 CRMB 60
-10°C or lower	PMB/NRMB 40 CRMB 50	PMB/NRMB 120 CRMB 55	PMB/NRMB 70 CRMB 50

Bituminous concrete

Providing and laying Bituminous concrete with 100-120 TPH batch type hot mix plant producing an average output of 75 tonnes per hour using crushed aggregates of specified grading, premixed with VG-30 Grade of bitumen @ 5.4-5.6% by weight of total mixture and filler, transporting the hot mix to work site, laying with a hydrostatic paver finisher with sensor control to the required grade, level and alignment, rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction as per MORTH specification clause No. 508 complete in all respects:Grade-1

MoRTH Clause 508 - BITUMINOUS CONCRETE

Scope

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25mm/40 mm/50 mm thick.

The coarse aggregates shall be generally as specified in Clause 505.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-18 and where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table : Physical Requirements for Coarse Aggregate for Bituminous Concrete

Property	Test		Specification
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Flakiness Index Elongetion index	Max 15% Max 20%	IS:2386 Part I
Strength	Los Angeles Abrasion Value Aggregate Impact Value	Max 30% Max 24%	IS:2386 Part IV
Durability	Soundness either : Sodium Sulphate or Magnesium Sulphate	 Max 12% Max 18%	IS:2386 Part V
Polishing	Polished stone value	Min 55	IS:2386 Part IV
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

4.59.2. QUALITY CONTROL

a) General

All works performed shall conform to the lines, grades, cross sections and dimensions as specified or as directed by the Employer's Representative subject to the permitted tolerances described hereinafter.

b) Horizontal Alignments

These shall be reckoned with respect to the center-line of the carriageway as specified. The edges of the carriageway as constructed and all other parallel alignments shall be "corrected within a tolerance of ± 20 mm there from.

c) Longitudinal Profile

The level of any point on the various surfaces after compaction shall comply with the following:

TABLE 4.18

Surface	Tolerance from the specified Level
Sub-grade	±25 mm
Sub-base	±20 mm
Base-course	±15 mm
Wearing course	±10 mm

However, the negative tolerance for wearing course, shall not be permitted in conjunction with the positive tolerance for the base course, if the thickness of the wearing course is thereby reduced by more than 6 mm.

The longitudinal profile shall be checked with a 3.0 m long straight edge, along the center-line of the road. The transverse profile shall be checked with a camber board at intervals of 30m. Permitted tolerances are specified in Table 4.19 below:

Table 4.19

Permitted tolerances of surface regularity for pavement courses

No.	Type of construction	Longitudinal profile (Maximum permissible undulation when measured with a 3 m straight edge) (mm)	Cross profile (Maximum permissible variation from specified profile when measured with a camber template) (mm)
1.	Sub-grade	18	12
2.	Sub- base	18	12
3.	Base-course	12	10
4.	Asphalt	10	8

d) Rectification

Where the surface irregularity of sub-grade and the various pavement courses falls outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Employer's Representative.

i) Sub-grade

Where the surface is high it shall be trimmed and suitably compacted. Where the same low, the deficiency shall be corrected by adding fresh material.

ii) Stabilized Sub-base

Where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. However, where the surface is low, the same shall be corrected as described herein below:

When the time elapsed between detection of irregularity and the time of mixing is less than 2 hours, the surface shall be scarified to a depth of 50 mm, supplemented with freshly mixed material as necessary and re-compacted to the relevant specification. When this time is more than 2 hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to specification. In either case the area treated shall not be less than 5m long 2m wide.

iii) Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 9.177 (c). The area treated at a place shall not be less than 5m long and 2m wide.

iv) Bituminous Construction

For bituminous construction other than wearing course where the surface is low, the deficiency shall be corrected by adding fresh material and compacting to specifications. Where the surface is high full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing coarse where surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where removal and replacement of bituminous layer is involved, the area treated shall not be less than 5m long and 2 m wide.

e) Quality Control Test during Construction

i) For ensuring the requisite quality of construction the materials and works shall be subjected to quality control test, as described hereinafter, by the Employer's Representative. The testing frequencies set-forth are the desirable minimum and the Employer's Representative shall have the authority to carry out tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

The tests and their frequency to be used for different materials and works shall be as detailed in the following Tables:

Table 4.20

Tests on earthwork for embankment construction

Sr. No.	Test	Frequency
1.	Plasticity	As directed by the Engineer
2.	Density	Each soil type to be tested. 1-2 tests per 8000 cubic meters of soil
3.	Deleterious content	As directed by the Engineer
4.	Moisture content	1 test for every 250 cubic meters of soil
5.	CBR test	As required by the Engineer

ii) Where specific procedure is not indicated for quality control tests, in these specifications, the same shall be carried out as per prevalent accepted Employer's Representativeing practice to the directions of the Employer's Representative.

iii) Compaction Control

Control shall be exercised by taking at lease one measurement of density for each 1000 square metres of compacted area or as required to yield the minimum number of test results for evaluating a day's work on statistical basis. The determination of density shall be in accordance with IS: 2720 (Part 28). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of anyone test but on the mean value of a set of 5 - 10 density determinations. The number of tests in one set of measurements shall be 5, as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subject to the condition that the mean standard deviation for any set of results is below 0.08 g/cc. However, for earth work in shoulders and in the top 500 mm portion of the embankment below the subgrade, at lease one density measurement shall be taken for every 500 square meters of each set of measurements shall be at least 10. In other respects the control shall be similar as described earlier.

4.59.3. SLAB CULVERT

Where slab culverts are provided for cross drainage purposes, these shall conform to the following specifications. The concrete works specifications for construction of RCC slab and the rubble masonry specification for the supporting rubble walls are given in these specifications (Part 9) and they shall be followed:

a) Bitumen at Location of Contact

The Bitumen to be used on the top of the bed concrete at the location of contact of RCC slab above in two coats, shall be straight run Bitumen of grade S 35 conforming to the specifications given in Table 9.17 of Clause 9.172 (f)

b) Graded Gravel Free Draining Backfill

On each side of the un-coursed rubble walls supporting the slab culvert a free draining backfill of thickness 200 mm shall be provided. The material for Section –9 [Part-C & F]: - Page-121 this backfill shall be granular, consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become dry powdery under loads and in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and shall meet the grading requirements given in Table 9.22 of Clause 9.182 (g).

c) Weep Holes

Weep holes as required or as directed by the Employer's Representative shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of uPVC pipes conforming to IS: 6908 in rubble walls with necessary M-10 concrete cushioning 75

mm thick. They shall extend through the full width of the masonry at a spacing of 1.5 mm c/c and with slope of about 1 vertical to 20 horizontal towards the draining face.

4.60. PIPE DRAINS

Where pipes are provided for cross drainage purposes, the sequence of construction shall be as follows:

i) laying of sand/ shingle bedding on the original ground,
ii) laying of PCC of M-15 grade
iii) laying of concrete pipes of Class NP2/NP3 as per IS: 458,
iv) constructing embankment above in compacted murrum, laying of the sub-base and water bound macadam as specified hereinabove.

Details of the above works as indicated in the specifications shall be followed:

a) Materials for Pipe Drains

All materials used in the construction of pipe drains shall be uPVC. Each consignment of pipes shall be inspected, tested if necessary, and approved by the Employer's Representative at the place of manufacture or at site before their incorporation in the works.

b) Excavation for Pipes

The foundation bed for pipe drain shall be executed true to the lines and grades as specified or as directed by the Employer's Representative. The pipes shall be placed in shallow excavation of the natural ground or in open trenches cut in the existing embankment, taken down to level as specified. Where trenching is involved, its width on either side of pipe shall not be less than 150 mm nor more than one third the diameter of pipe. The sides of the trench shall be as nearly vertical as possible. When during excavation the material encountered is soft, spongy or other unstable soil and unless other special construction methods are called for, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Employer's Representative. Before placing any backfill material exposed surface of the soft soil shall be lightly compacted with one Pass of a 0.5 T roller. On the lightly compacted surface, coarse sand and shingle shall be spread in two successive by rolling with a min. 0.5T roller and with a minimum of 10 passes each, both in longitudinal and transverse directions. Where bed rock or boulder strata are encountered, excavation shall be taken down at least 200 mm below bottom level or the pipe as directed by the Employer's Representativeand the space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes. Trenches shall be kept free from water until the pipes are installed and the joints have been hardened. For this purpose, the Contractor shall suggest a suitable method for diverting the water.

c) Bedding for Pipe

The bedding surface shall provide a firm foundation of uniform density throughout the length of the pipe drain and shall conform to the specified level and grade. The pipe shall be bedded in a cradle constructed of concrete having a mix not leaner than M-10 conforming to the specifications under the same section. The pipes shall be laid on the concrete bedding before the concrete has set.

d) Laying of Pipes

No pipe shall be placed in position until the foundations have been approved by the Employer's Representative. When pipes are to be laid adjacent to each other, they shall be separated by a distance equal to or greater than half the diameter of pipe subject to a minimum of 450 mm. The laying of pipes on the prepared concrete foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid they form a drain with a smooth uniform invert. Any pipe found defective or damaged during laying shall be removed and a new pipe substituted in its place at the cost of the Contractor.

e) Jointing

All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. The ends of the pipes shall be so shaped as to form a self-centering joint with jointing space 13 mm wide. The jointing space shall be filled with cement mortar (1 cement to 2 sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. Care shall be taken to fill all voids and excess mortar shall be removed. After finishing, the joints shall be kept covered and damp for at least four days.

f) Back-Filling

Trenches shall be backfilled with murrum in accordance with the specification. Backfilling upto 1.0 metres above the top of the pipe shall be carefully done and murrum shall be thoroughly consolidated under the haunches of the pipe.

Before laying the filter medium, the sides of the banks shall be trimmed to the required slope. Depressions shall be filled and thoroughly compacted. The filter granular material shall be laid over the prepared base and suitably compacted to a thickness of 75 mm unless specified otherwise on the specification drawings.

4.61. BUILDING WORK

4.61.1. GENERAL

All the building works shall generally comply with the following specifications unless specified otherwise in further description in this part:

Unless otherwise specified, all the building and structure works shall generally comply with the following Employer's Requirements:

1. All building works shall be in reinforced concrete framework.
2. All external walls shall be In 200 mm thick brick masonry built in cement mortar in (1:6).

3. All internal partition walls shall be in 100 mm thick brick masonry built in cement mortar 1:6. Transoms and mullions shall be of size 100 mm x 200 mm and shall from panels not exceeding 3500 mm x 3500 mm in size.
4. All internal masonry surfaces shall be finished with 12 mm thick smooth faced cement plaster mortar (1:4). The walls shall be finished with painting and the type of painting shall be in accordance with the one specified in clause 12.5 of standard specifications (civil work).
5. All external masonry surfaces without rock facing shall be plastered in two coats with sand faced cement plaster in cement mortar (1:4) and shall have total thickness of 20 mm. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.
6. All external surfaces above ground level shall be painted as specified in clause12.20 of standard specifications (civil work)
7. Bathroom/ W.C. floor slabs shall be sunk and filled with brickbat coba (broken bricks set in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company. The finished floor level in Bathroom/ W.C. areas shall be 25 mm below the finished floor level on the outer side.
8. Wherever specified, staircases shall be finished with 25 mm thick KotaStone treads and 12 mm thick Kota Stone skirting. The rise of stairs shall not exceed 170 mm and minimum width of the tread shall not be less than 275mm.All steps shall have 20 mm nosing.R.C.C. stairways shall be provided to permit access between different levels within buildings. All roof tops and tops of overhead tanks shall be made accessible with ladder provision. Vertical ladders fitted with landing point extensions will be permitted where considered appropriate by the Employer's Representative to access areas not frequently visited.
9. Admin building hand rail should be of stainless steel SS 304.
10. All floor cutouts and cable ducts, etc. shall be covered with pre-cast concrete covers in outdoor areas and GRP chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with SS-304 hand railing fixed with two rails.
11. Top railing and vertical of the SS-304 railing shall be 32 mm dia.. The lower railing shall be 25 mm dia. SS-304.
12. All staircases shall be provided with SS-304 hand railing.
13. The reinforced concrete roofs shall be made waterproof by application of approved cement/ lime based waterproofing treatment, guaranteed for 10years. The finished roof surface shall have adequate slope to drain quickly the rainwater to R.W. down-take points.
14. For roofing drainage, cast iron rainwater down-takes with uPVC mouth covered with D.I. grating at top shall be provided. For roof areas up to 40 sqm. minimum two nos. 100mm diameter down-take pipes shall be provided. For every additional area of 40 sq m or part thereof, at least one no. 110 mm OD. down take pipe shall be provide. The RW pipes shall preferably be concealed.
15. Top surface of chajjas and canopies shall be made waterproof by providinga screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rainwater.

16. Building plinth shall be minimum 450 mm above average finished ground level around building.
17. All concrete channels and ducts used for conveying liquid shall have smooth finish from inside. The width of concrete channels shall not less than 500mm. All open channels shall be provided with SS-316 with catahodic protection hand railings.
18. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of the Factory Act.
19. All rooms in the treatment plant building shall be provided with appropriate signboards indicating the function of the rooms involved.
20. Wherever equipment and machinery is required to be moved for inspection servicing, replacement etc, suitable movable gantry of required capacity shall be provided.
21. The design of building shall reflect the climatic conditions existing on site Process buildings shall as far as is possible permit the entry of natural light and the use of glazed paneling shall be kept to a minimum.
22. Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.
23. Toilet blocks in process building shall be provided with a sink with two drinking water taps of 12 mm size with appropriate drainage.
24. Drinking water shall be supplied from an overhead tank to be constructed on Chemical & Coagulant Storage House. All plumbing work shall be carried out in GI pipes of Class-C/Polyproprelene.
26. Opening of the windows shall be minimum 25% of the wall area.
27. Minimum floor area of various units shall be as given table – B.30. Anti-termite treatment process as per IS: timber care ground treatment chemically emulsion 1:3 and creating a chemical barrier under and around the column pits, wall trenches, basement excavation, top surface of plinth filling, junction of wall and floor along the external perimeter of building, expansion joints, surrounding.
28. Roof sheeting should be of colour coated profile sheet of nom 1015 mm effective cover width and nominal 28 mm deep ribs with subtle square fluting in the pan at nominal 203mm centre-to-centre. The end rib shall be designed for anti-capillary action, to avoid any seepage of water through the lateral overlap. The feed material is manufactured out of nominal 0.60 mm Base Metal Thickness (BMT), Hi-Strength steel with min. 550 MPa yield strength, metallic hot dip coated with Aluminium-zinc alloy (55% Aluminium, 45% Zinc) as per AS 1397- Zincalume AZ150 (Min. 150 gms/sq.mt total on both sides) with Colorbond steel quality paint coat as per AS/NZS 2728 type 3 – 4 of BlueScope Steel make. The profile sheet, fastener size etc. needs to be approved by the concern authority. All the accessories like gutter/ flashing / capping shall be made from the same material (either soft steel or Hi strength steel) which is used for main cladding application.

    STEEL SHEET MATERIAL

    Base Steel: The steel base material of sheet shall manufactured from 0.45 mm (nominal) base metal thickness with minimum 550 MPa Yield Strength. The steel manufacturers test

certificate for the chemical and mechanical properties of steel must be concerned authority prior to installation.

Metallic Coating: The sheets shall have a hot dip metallic Aluminium-Zinc alloy coating of Aluminium (55%) & Zinc (45 %) with total mass coating of 150 gms/sq.mt on both sides as Zincalume AZ150 or equivalent coating as per AS 1397.

Colour Coating: The coated sheets shall be factory painted and oven-baked conforming to AS/NZS 2728 type 3- 4, the total coating thickness of 35 µm (nominal) of Colorbond steel quality paint system of BlueScope Steel make, comprising of nominal 20 µm exterior coat on top surface and nominal 5 µm reverse coat on back surface over nominal 5 µm primer coat on both surfaces of approved colour shade. The sheet shall have brand marking of the manufacturer giving product details on the back of the sheet at every 1 mtr c/c for confirming genuinity of the material.

29. Specification language for Skylight Translucent sheeting

The panel shall be nominal 1.5 mm thick, composed of a translucent, thermosetting polyester resin with a thoroughly impregnated glass fiber reinforcing mat (FRP) with or without an integrally bonded translucent film on the weathering face comply with AS/NZS 4256. The profile should match with cladding profile. The fixing shall be done with specially designed Lapseal and weather-tight washer for fixing the translucent sheeting. The profile and properties shall be approved by Engineer-in-charge before installation

4.61.2. CEMENT/ LIME MORTAR

Mortar for brickwork and stonework shall be prepared, in accordance with IS: 2250. Cement mortar shall consist of Portland cement and sand in proportions specified elsewhere. Lime mortar for laying of tiles shall consist of one part of cement, 2 parts of lime and 6 parts of sand.

Mortar shall be mixed on clean, hard dry platforms protected from sun and rain. The constituents shall be measured using properly made gauge boxes and shall be thoroughly mixed dry before water is added. Any mortar not used 30 minutes after the water is added shall be discarded.

For lime mortar, lime from burn stone shall be used. It shall be free from ash and impurities and be in the form of lumps and not powder when brought to site. Lime which is damaged due to rain, soaking, moisture or air slaking shall not be used.

Portland cement for mortar shall comply with IS: 269.

Sand for mortar shall comply with IS: 2116 and shall be of the following grading:

I.S. Sieve	Percentage passing by Weight
4.75 mm	98 - 100
2.36 mm	80 - 100
1.18 mm	60 - 80
600 microns	40 - 65

300 microns	10 - 40
150 microns	0 - 10

Sand for mortar shall be from an approved source and shall consist of hard, coarse siliceous grains free from deleterious matter. It shall be stored separately from other sand or fine aggregate and shall be kept covered. The Contractor shall submit samples of sand for mortar for the Employer's Representative's approval if ordered. Water for mortar shall comply with Clause 9.75

4.61.3. BRICKS

Bricks for common brickwork shall be whole, sound, well burnt clay bricks free from cracks and shall comply with the requirements of IS: 1077. Samples of bricks to be supplied shall be submitted to the Employer's Representative for his approval. Clay Project Managering bricks shall comply with the requirements of IS: 2180.

Bricks shall not be tipped on the site but shall be carefully stacked by hand in separate stacks. Broken or damaged bricks shall not be used in brickwork.

Crushing Strength = 50 kg/cm2
Water Absorption = not >25% for partition walls
Size = Tolerance Allowed = 3.3% positively

4.61.4. BRICKWORK

Brickwork shall be built in accordance with the requirements of IS: 2212. Every brick shall be wetted and laid on a full and close joint of mortar on its bed side and end in one operation, joints being fully flushed up as the work proceeds. Previous course shall be wetted if it has dried and the walls shall be brought up evenly with no portion racked up (and not toothed) more than one metre higher than another. All brickwork shall be properly bonded together. Joints shall not exceed 10mm in thickness and shall be raked out a depth of 7.5mm as a key for rendering or plastering. All courses shall be truly horizontal and all perpendiculars shall be strictly plumb and square.

In the cavity walls the two leaves of brickwork shall be bonded with galvanized wall ties 150 mm to 250 mm long as required. The ties shall be built into the horizontal joints as the work proceeds and the space between successive ties shall not exceed 750 mm horizontally nor 250 mm vertically. Ties shall be staggered and shall be laid sloping down towards the outer leaf of the cavity. Cavities shall be kepi free from mortar droppings by the use of suspended battens and temporary openings at the bottom of the wall. Every fourth vertical joint in the external face in the course immediately above the horizontal damp proof courses shall be raked out and left open to form a weep hole. Completed brickwork shall be kept wet for a minimum period of 14 days.

4.61.5. CONCRETE BLOCKS

Concrete blocks whether made on or off site shall be manufactured to the shapes, sizes and finishes as specified or directed by the Employer's Representative and shall comply with the requirements of IS: 2185. The Contractor shall submit full details of his proposed

manufacturing arrangements to the Employer's Representativefor his approval before making any blocks for use in the works and shall submit such samples as may be needed to demonstrate the quality of the finished product. Production of blocks shall be of equal standard to the approved sample blocks.

Concrete for blocks shall be made generally in accordance with section C of the specifications except that the combined aggregate shall have a fineness modulus lying between 3.6 and 4 and shall conform with the following grading:

I.S. Sieve	Percentage passing by Weight
12.5 mm	100
10 mm	>85
4.75 microns	>60
300 microns	>10

Concrete for blocks shall be minimum Class M-20. Hand mixing shall not be permitted. When ordered by the Employer's Representative, sample block from any batch shall be tested as specified in IS: 2185. Finished block shall be neatly stacked for storage on firm dry support and shall be covered to protect them from dirt, sun and rain. Damaged blocks shall not be used in the works.

4.61.6. BLOCK WORK

Concrete blockwork shall be laid generally as specified for brickwork above except where specified otherwise or as directed by the Employer's Representative. The construction of hollow block masonry shall be generally in accordance with IS: 2572. Block work for partition walls shall be laid in stretcher bond. Fair face block work which is not to be plastered shall be neatly pointed as specified.

4.61.7. UNCOURSED STONE MASONRY

Uncoursed stone masonry shall be built in layers not exceeding 450 mm in height. No stone shall be less in breadth than 14 times its height and less in length than twice in height. Every stone whether large or small shall be laid in its natural bed and set flush in mortar, and the small stones used for wedging or filling being carefully selected to fit the interstices between the large stones. Care shall be taken to see that no dry work or hollow space is left in the masonry. The stones shall be so arranged as to break joints at least every 80mm and long vertical joints of joints shall be avoided. The joints at the face shall be finished off neatly, being struck and smoothed with a trowel, while the mortar is fresh. The upper surface of the work shall be brought to a uniform level at the height of each course. The faces of masonry walls shall be kept in perfect plumb and where batter has to be given it shall be uniform. The stones at all comers and junctions of wall shall be of large sizes and hammer dressed to the concrete angle.

Each stone shall be thoroughly wetted before being used in the work. The masonry shall be kept thoroughly wet during the progress of the work, (care being taken to water it even on Sundays and Holidays, special labour being employed if so required for this purpose)

until it becomes hard. As far as practicable, the whole of the masonry shall be raised in one uniform level and no part of the masonry shall be allowed to rise more than 1 metre above the rest to avoid unequal settlement. If raising one part of wall before the other becomes unavoidable the end of the raised portion shall be racked back in steps to prevent cracks developing at the junction of the old and new work. Care shall be taken to see that the sides of the wall are not built separately from the hearting, the faces and internal filling being done simultaneously. The stones shall overlap and cross each other as much as possible. No course shall be laid unless the previous close is perfectly set.

At least one header or through stone per square metre of wall face shall be built into the work. The headers or through stones shall be at least 0.05 m2 in area at face and shall have at least 0.025m2 area at the back face. Where the thickness of the wall is more than 600 mm a series of through stones shall be laid through the work so as to form front to back, breaking joints or overlapping each other for at least 150 mm. No stone whose length is less than 600 mm shall be used in such work as a header.

All the through stones shall be marked inside and outside and the marks shall be retained until ordered by the Employer's Representative to be removed. Sufficient number of headers shall be collected on site before commencing any masonry work. Where adequate sized through stones are not available in required quantities, the use of pre-cast plain concrete headers in M-20 mix may be permitted at the discretion of the Employer's Representative. No extra payment will be made for the provision of substitute headers in concrete.

Quoins shall be 150 mm high and formed of header stones at least 300 mm long. They shall be laid lengthwise alternately along each face and square on their beds, which shall be dressed to a depth of at least 80 mm.

Weep holes 80 mm wide and 150 mm in height shall be provided in retaining walls at the rate of one square metre as specified or directed. They shall be pointed with 1 : 2 cement sand mortar after raking the joints to a minimum depth of 25 mm.
Completed masonry shall be kept wet for a minimum period of 14 days, hi wet weather newly laid masonry shall be protected from the effects of heavy rainfall by tarpaulins or other approved material.

4.61.8. POINTING OF UNCOURSED MASONRY

Joints in exposed masonry faces shall be formed while the mortar is still green and shall be finished as flush joints, weathered joints, round-recessed joints or square-recessed joints as directed by the Employer's Representative. Masonry which is to be rendered or plastered shall have the joints raked out to a depth of 1 5 mm to form a key.

4.61.9. STONE PITCHING

Stone pitching to slopes shall be carried out where specified or as directed by the Employer's Representative. Stone for pitching shall be obtained from an approved source and shall be hard, sound, durable, clean and generally as specified. The minimum dimension of any stone shall be at least equal to the specified thickness of the pitching.

After excavation and trimming, slopes to be pitched shall be spread with as 75 mm thick layer of crusher run rock or graded coarse aggregate ranging from 75 mm particle size to fines. The slope shall then be hand packed with hard broken rock to a total thickness of 150 mm, each stone being individually placed and rammed home, with smaller stones edged into the cracks. 50 mm dia weep-holes shall be provided where specified at intervals not exceeding two metres in both directions. Joints in stone pitching shall be flushed up with sand/cement mortar on completion.

4.61.10. RUBBLE STONE PACKING

Rubble used for packing under floors, foundations, etc., shall be hard and durable rock, free from veins, flaws and other defects. The quality and size of the rubble shall be subject to the approval of the Employer's Representative.

The rubble stone shall be of best variety of black trap / granite / basalt or other approved variety of stone available locally. The stone shall be hard, durable, free from defects and of required size and shall be approved by the consultant before incorporation in the work.

The bed on which rubble soling is to be laid shall be cleared of all loose materials, leveled, watered and compacted and got approved by Employer's Representative

Small interstices shall be filled with hard clean sand and well watered and rammed. Cable or pipe trenches if shown in the drawing and as required by the Consultant shall be got done before the soling is started. Over the prepared surface, the stone shall be set as closely as possible and well packed and firmly set. The stones shall be of full height and shall be laid so as to have their bases of the largest area resting on the sub-grade. Soling shall be laid in one layer of 230mm or 150mm or other specified thickness and no stones shall be less than 230mm or 150mm depth or specified thickness of soling with a tolerance of 25mm. After packing the stones properly in position, the interstices between them shall be carefully filled with quarry spoils of stone chips of larger size possible to obtain a hard, compact surface. Spreading of loose spoils or stone chips is prohibited.

All interstices shall be filled with approved murrum. Excess murrum if any over the surfaces shall be removed. Unless otherwise specified, the murrum shall be supplied by the Tenderer at his own cost from the selected areas. The surfaces shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log-rammers as approved by the Consultant to give the required slope or level and dense sub-base. After compaction, the surface shall present clean look. Adequate care shall be taken by the Tenderer while laying and compacting the rubble soling to see that concrete surfaces in contact with soling are not damaged.

RUBBLE SOLING

Rubble soling for road work including foot paths, culverts, side drains etc. shall be carried out as specified here-in as above for rubble stone soling, as far as they are applicable, with the following additions.

Subgrade for soling shall be prepared by cleaning of all foreign substances including rank vegetation, if any. Any ruts or soft yielding places that appear due to

improper drainage conditions, traffic, hauling or from any other cause shall be corrected by filling/cutting upto 150 mm and compacted and the Subgrade dressed off parallel to the finished profile and the same shall be approved by the Consultant, before laying of soling. Soling shall be laid in regular lines and staggered joints. The stones shall be laid as closely as possible and packed well. The stones shall be so laid as to have their bases and the target area resting on the Subgrade and in contact with each other.

Soling shall be laid to proper gradient and chamber, which shall be checked frequently to ensure accuracy. Rolling shall then be carried out by a 8 to 10 t power roller and soling consolidated properly shall be lightly sprinkled during rolling, if ordered by the Employers Representative. The surface thus prepared shall first be passed by the Consultant, after which 40mm to 50mm thick layer of selected hard murrum available from excavation shall be spread over the soling as directed by the Consultant, and rolled again such that the hard murrum gets into the interstices, It shall, however, be ensured that a thin layer of murrum/grit shall remain on the finished surface of soling. The area of soling actually done of specified consolidated thickness limiting to the dimensions as per drg. Shall be measured in square metre upto two decimal places.

4.61.11. FINISHES IN GENERAL

The Contractor shall demonstrate his ability to apply finishes to the standards required under the Contract. If in the opinion of the Employer's Representative, the demonstrations do not satisfy the standards required, the Employer's Representativemay order the Contractor to employ a specialist firm of subcontractors approved by the Employer's Representative to carry out all or part of this work.

4.61.12. FLOOR SCREEDS

Where required or specified, dense concrete floor screeds shall be placed over the structural concrete floor. Before the structural concrete is fully hardened, the surface shall be roughened by wire brushing or pickling in order to expose the aggregate. Immediately before laying the screed, the concrete shall be cleaned with stiff brushes and then thoroughly dampened. Before the screed is laid and after the excess water has been removed, a thin layer of stiff cement grout shall be well brushed into the roughened surface.

Where directed by the Employer's Representative approved water proofing admixture shall be added to screed concrete in accordance with the manufacturer's recommendations.

Heavy duty screeds shall be in M 20 concrete. The coarse aggregate shall be well graded to a maximum size of 12mm. Light duty screeds shall consist of 1 part Portland cement by weight to 4 parts sand. Water content shall be kept to the minimum consistent with providing adequate compaction. Unless otherwise specified, screeding shall be finished to a U2 quality.

Screeds shall be laid to the walls shown in the specification drawings subject to minimum fall of 1 in 120. The minimum thickness of screed shall be 60 mm for heavy duty and 40 mm for light duty. Curing of screeds and quality of materials shall conform to Section C of the specification.

4.61.13. INDIAN PATENT STONE FLOORING

The Indian Patent Stone Flooring shall be 50nmm in thickness and shall consist of cement concrete mixed in the proportion of 1: 2: 3 (with 12.5 mm chips only) with an admixture of approved water-proofing compound. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

It shall be laid, after applying to the surface neat cement slurry, in bays of suitable sizes but not exceeding 6 sq.m. each, and required slope in a chess board alternate panel fashion and neatly finished smooth in red colour where directed with lines drawn as directed. The concrete shall be cast against teakwood stop-off boards, which shall be removed only after the concrete is set.

No dry cement shall be allowed to be used for finishing the surface. Mechanical mixing may be resorted to.

The surface shall be kept well watered after it is dry, for period of 8 days.

Construction joints shall be formed in between the sequential panels cast, with straight edges, 20 mm deep and 12 mm wide in groove form. These joints on completion of work, shall be cleaned and washed free of dust with the help of brush and shall be treated with hot bitumen poured in the gap, over which fine sand shall be spread to arrest the flow of bitumen.

4.61.14. SHAHABAD/ TANDUR/ KOTA STONE FLOORING

Stones shall be of approved quality, hard, sound, durable and of uniform thickness. Edges shall be chisel dressed and the top surface shall be machine polished with joints running true and parallel from, side to side. Stones shall be laid on a bed of lime mortar of proportion 1: 2 or cement mortar or proportion 1: 4. Thickness of mortar bedding shall not be less than 12 mm and not more than 25 mm. Before laying, the stone slabs shall be thoroughly wetted with clean water. Thick cement slurry shall be spread over the mortar bed over as much area as could be covered with the stone slabs within half an hours. The slabs shall then be laid and gently tapped with mallet till they are firmly and properly bedded. There shall be no hollows left. The joints shall not be more than 2mm wide and shall be struck smooth. The floor shall be kept covered with damp sand or water for a week. Slabs shall be of standard sizes and shapes and shall meet all the required properties and test requirements as stipulated in IS: 1124.

Stones in skirting shall be laid against a bedding of cement mortar 1: 4 20mm thick to the full height of skirting, to a true plane, level and plumb,. The workmanship shall be similar to flooring. The skirting shall be laid projected beyond the finished plastered surfaces. The continuous horizontal grooves at the top of skirting shall be provided if required. The

skirting surfaces shall be repolished with hand to the satisfaction of the Employer's Representative. The skirting shall be cured for 7 days. Top of exposed skirting shall be machine cut and polished. The used at projecting corners shall be suitably leveled to present as neat corner.

4.61.15. TILE FLOORING AND DADO

Glazed tiles including angles, corners, borders and specials shall be of the approved make and quality, Johnson or equivalent with mat finish.

The tiles before laying shall be soaked in water for at least 2 hours and shall be set in lime concrete mortar of one part of cement, two parts of lime for dado to walls. Tiles which are fixed in the floor adjoining the wall shall be so arranged that the surface of the round edge tiles shall correspond to the skirting or dado. Neat cement grout of honey like consistency shall be spread over the bedding mortar just to cover so much area as can be toiled within half an hour. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight lines. The joints between the tiles hall not exceed 1.5 mm in width.

4.62. ACID AND/ OR ALKALI RESISTANT TILE FLOORING AND DADO

a) Materials

The acid and/or alkali resistant tiles shall have true and straight edges, shall be non-absorbing, without stains, non-fading, shall conform to IS : 4457 and approved manufacturers.

b) Laying and Workmanship

The surface over which tiles are to be laid shall be plain and plumb and without uneven depressions. It shall be chemically etched with 15 % commercial hydrochloric acid and then washed with alkaline solution. Subsequently, the surface shall be washed with sufficient water until it is fully neutralized.

After the underbed is thoroughly dried, it shall be cleaned thoroughly with wire brushes to remove all loose particles and brushed properly to obtain a completely dust free surface. A heavy grade bituminous corrosion resisting protective coating shall be applied on this dust free surface either by brushing or other means in accordance with manufacturer's specifications so as to provide an isolating layer between the Portland cement concrete and the acid-alkali resistant treatment as well as to provide a proper bonding between the same.

This bituminous material; shall be resistant to the splashes and fumes of both inorganic acids and alkalis and should form an elastic film not subject to flaking. Prodorlac SPL as marketed by Coromandel Prodorite Pvt. Ltd. or equivalent may be used for this bituminous lining and the number of coats provided as per manufacturer's recommendation, if a multiple coat is used, sufficient drying period shall be allowed between completion of one coat and application of the next as recommended by the manufacturer, and depending on

the prevalent temperature. On top of minimum thickness or as recommended by the manufacturer shall applied to provide an impervious underlay membrane to the tiling. This special mastic shall consist of a primer and a mortar. Both these shall be thermoplastic compound of selected fillers and blended bitumens which are solid at ordinary temperatures.

The primer shall be broken up into small pieces and put into cauldron and heated. During heating care shall be taken that the primer does not burn, it is essential to keep it in motion as a preventative measure. When the primer is hot enough to flow like a liquid it is to be poured over the undercoat surface and promptly spread to uniform thickness.

Care shall be taken to avoid moisture entrapment on the surface and to eliminate bubbles. Two layers of primer are normally suitable, but manufacturer's recommendation in this regard shall prevail.

The mortar is to be heated as required to make a stiff paste similarly breaking up into fairly small pieces and melted in the cauldron. When it reaches a butter like consistency, it is to be applied on to the primer applied surface in single or multiple layers as to form a total thickness or the special mastic membrane of at least 12 mm or as required by the manufacturer's specification. The mortar shall be applied hot either by trowelling or by means of a standard wooden float and thoroughly worked in until it forms an even coating. The covering shall be done piece by piece and care taken to keep the correct temperature, so that a perfect weld is made. The special mastic material may be the product of Coromandel Prodorite Pvt. Ltd. or equivalent. Over this underlay the acid/ alkali resistant resin based cement mortar.

The bedding mortar shall have a bed thickness not less than 6 mm. The material shall be self-hardening, chemically setting silicate type and chemical resistant comprising an intimate mixture of solid filler, a setting agent usually contained in the filler and a liquid binder.

The material may be supplied in tow components, powder and solution. When the filler powder and the liquid binder are mixed at ordinary temperature, a trowelable mortar shall be formed which should subsequently harden by the chemical reaction between the setting agent and the silicate binder forming an insoluble silica gel. The liquid binder may be neutral solution of sodium silicate and/ or potassium silicate and the fillers may be silica, quartz or other material insoluble hi common mineral acids.

The jointing of the tiles shall be done with a self-hardening cement mortar specially designed to resist both acidic and alkaline as well as mixed acidic and alkaline conditions. For this purpose a resin-type chemical resistant mortar conforming to IS: 4832 Part II shall be used comprising an intimate mixture of liquid resinous material and a powder composed of properly selected filler material and a powder composed of properly selected filler material and usually containing the setting agent. The material may be supplied in two components which when mixed at ordinary temperature shall form a trowelable mortar that subsequently hardens. The liquid resin may be either one of or a combination of the types like phenolic resin, furane resin, epoxy resin and polyester resin. The filler materials, which

are usually of a carbonaceous or siliceous nature shall be selected to have resistance particularly to hydrochloric acid and caustic soda. The catalyst material may be incorporated in the fillers is such a manner that it becomes effective when mixed with resin. For phenolic and furane resin mortars the resin and the filler may be supplied in two packs. The resin shall have a viscosity that will permit it to be readily mixed with the powder by manual methods. The filler materials shall have properly graded particles that will permit the preparation of a minimum joint thickness of 1.5mm.

The mortar is to be prepared and applied strictly in accordance with the manufacturer's instructions, If the material is supplied in two separate parts, an inert powder and a resin based syrup, they must mixed in the proportions given by the manufacturer's data table.

The jointing shall be done for the full depth of the tile and the joint width shall be 3 mm. The joints shall be finished smooth and flush printed.

Mixing shall be carried out very thoroughly and carefully in a clean enamelled dish or bowl. Any lumps in the powder shall be broken down by careful mixing. Mixing shall be carried out by adding powder to the syrup. The mixing shall be arranged that the mixed mortar is used up quickly and does not remain in bulk longer than the time specified by the manufacturer. At a temperature of 200°C or above, the mixing pan and contents shall be kept cool by immersion in water. All necessary measures should be taken so that the bulk masses of this resin based mortar, which generates heat in setting, are not allowed to remain under fairly warm conditions which may lead to a flash set. To avoid this, it is essential that the mixed mortar is spread in a thin layer on a flat tray and not left in a mass. After jointing the tiles, the flooring should not be placed under service in normal conditions before eight days or as recommended by the manufacturer and depending on atmospheric temperature. During setting and hardening, no water, steam or acid should come in contact with flu's jointing mortar.

If the flooring has to be sloped the same shall be provided in the concrete slab or an additional graded under-bed shall be provided if required, with cement sand mortar(I:3) by volume as specified or as directed by the Employer’s Representative.

The Contractor shall furnish full details regarding the materials for the different treatments described above pertaining to this flooring works as per manufacturer IS specifications, shall lay under-layer, special mastic, setting mortar etc. and set the tiles properly in full conformation with the manufacturer's instructions. The entire work shall be done in workmanlike manner to the complete satisfaction of the Employer’s Representative.

4.63. HEAVY DUTY ABRASION FLOORING

The type, quality, size, thickness, colour, etc., of the tile for flooring and skirting work shall be of the best quality approved by the Employer’s Representative. For this purpose, the Contractor shall provide the Employer’s Representative with necessary samples for his selection. Tiles shall be hardwearing, resistant to impact, resistant to abrasion, free from slipperiness and also resistant to attack by water, oils and greases. The tiles shall be laid on lime concrete mortar bedding of about 30 mm thick to give an overall thickness of 50mm. The laying procedure shall be similar to Clause 9.214.

4.64. INTEGRAL CEMENT FINISH ON CONCRETE FLOOR

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded, off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface.

4.65. BRICK BAT COBA CHINA MOSAIC TYPE WATER PROOFING

In case of works where brick bat coba and china mosaic are specified, brick bat coba of average thickness shall be laid to the required slopes as shown on the drawing .Proportion of brick bat shall be 2 parts of brick bat to one part of lime mortar (one part of lime to 2 parts of sand). The brickbats shall be hard, well burnt and of size varying from 12 mm to 25 mm. Lime shall be of best quality of hydraulic lime double ground.

While preparing brick bat concrete, jaggery in portion indicated by the Employer's Representative shall be added.

The brick bat coba shall then be laid to slopes, providing necessary wattas, and beated at least for 48 hours after laying. Over the brick bat coba a bedding of 1: 2 lime mortar 20 mm to 25 mm thick, shall be provided. A layer of neat cement grout, about 10 mm thick shall then be laid. Immediately on application of cement grout, assorted pieces of coloured china, previously soaked in water shall be set closely on the fresh surface and properly tamped to the required grade. The cement grout freshly prepared shall be laid to the top surface. The surface after completion of work shall be finally cleaned with saw dust, and waste and if so directed by the Employer's Representativewith dilute acid. China mosaic shall be cured for at least 10 days. If so directed by the Employer's Representative, a border of colour or white mosaic shall be provided.

Brick bat coba and china mosaic shall be taken up the parapet walls to height of 125 mm to 150 mm. Necessary fillet shall be provided towards drain pipes as shown on drawings or as directed by the Employer's Representative.

On prior approval from the Employer's Representative, cement base proprietary type of waterproofing may be allowed to be done by a specialist Contractor.

The Contractor shall give a guarantee of waterproofing for a minimum period of 10 years against bad or faulty material and shall rectify the work at his own cost during the guarantee period.

4.66. Waterproofing Work

The Contractor shall give a guarantee for all waterproofing against bad or faulty material and construction and shall rectify the work at his own cost during the O&M period.

(a) All surfaces to be waterproofed shall be dry, clean, smooth and free from dust and loose particles. Water proofing treatment shall be as per specifications of approved specialist

waterproofing company and shall consist of brickbat coba covered with jointless waterproof plaster finished smooth with trowel in cement mortar with false marking of 300 mm squares.

Waterproofing treatment shall be taken up the parapet walls to a height of about 300 mm in shape of round fillet or as directed by the Employer's Representative.
Thickness of brickbat coba shall be as specified by the specialised agency. Additional thickness of brickbats shall be provided wherever there is an increased length of travel of rainwater and in such portions of baths, water closets, nahani, etc. as specified and as directed by the Employer's Representative.

(b) Where bitumen felt waterproofing is adopted, it shall be of a seven layer treatment over a properly sloped screed. The layers of bitumen felt shall conform to IS: 1322. The first layer of bitumen felt shall be bonded to the dry, clean and smooth concrete surface by bitumen bonding compound. The successive layers of bitumen felt shall be bonded together with hot bitumen bonding compound as described in IS: 1346 and IS: 3037. Bitumen felt shall be Shalimar or similar approved, laid with 50 mm side laps and 75 mm end laps staggered. The felt shall be laid continuously over the surface of the roof and shall not be terminated at expansion joints.

4.67. NEERU PLASTER

Cement and sand shall conform to IS: 269 and IS: 383 respectively.

Neat lime shall be made of the best description of lime, slaked with fresh water and sifted. The lime shall be reduced to fine powder by grinding it on a stone or in a hand mill as directed by the Employer's Representative. The neat lime thus prepared shall be kept moist until used and the quantity to be prepared at one time shall be such that it can be consumed within eight days.

All stone or brick masonry surface shall be thoroughly wetted for atleast 6 hours and the joints raked out to a depth of at least 12 mm and walls washed before any plastering is done. The surface shall then be rendered with 1:4 cement sand plaster with specified roughness. The surface shall then be floated or set with a thin coat, 3 mm thick, of cement and polished will with a trowel or flat board. The cement mortar shall be used within 30 minutes after it leaves the mixing board or mill. Before any plaster work is started patches of plaster 150 mm x 150 mm shall be put on at every 3 metres as gauges so as to ensure an even thickness throughout the work. Cement plaster shall be done in even squares or strips. Care shall be taken to keep the whole surface thoroughly wetted for at least a week. The finishing surface shall be as specified and directed. Neat lime finish shall be applied to the prepared and partially set but somewhat plastic surface with steel trowel to a thickness slightly exceeding 1.5mm, (1/16") and rubbed down to 1.5mm, (1/16") thickness and polished to a perfectly smooth and even finish working from top to bottom. The total thickness of the plaster shall be at least 12mm.

The junction between beams and brickwork shall be plastered after fixing the expanded metal wire mesh of 300 mm width 10mm deep and 15mm wide grooves shall be provided between concrete & brick surfaces.

4.68. SAND FACED CEMENT PLASTER

Cement and sand shall conform to IS : 209 and IS : 383 respectively. The sand faced cement plaster, where specified shall be applied in two coats. All stone or brick masonry surface to be plastered shall be thoroughly wetted for at least 6 hours and the joints raked to a depth of at least 12mm and walls washed before any plastering is done.

The first coat of cement plaster in 1:3 cement sand mortar shall be applied uniformly all over the surface to be plastered to a thickness of 14mm with a trowel and in exact plumb. This coat shall be allowed to set for not less than half an hour. Indentation shall then be made in the form of waves by raking a wire broom over the surface to form a key for the second coat. Water proofing compound such as CICO, Impermo etc. shall be added in the 1st coat of cement plaster at the rate of 1.50 kg per bag of cement oral the rate specified by the manufacturer for its effective results. The plastered surface shall be allowed to cure for at least four days.

The second coat shall be applied in 1:3 cement sand mortar using clean sand screened through a mesh of not less than 1.5mm and not more than 3.00 mm size to a uniform thickness of 6mm by trowel and flat board in exact plumb. The surface shall then be tapped with a cork, piece to give a desirable uniform granular appearance. Care shall be taken for keeping the whole surface thoroughly wetted for at least one week.

4.69. EPOXY LININGS

The Contractor shall employ specialist firms, approved by the Employer's Representtaive, for the supply and laying of epoxy linings on the surface of the concrete. The epoxy shall be food grade and shall comply with the requirements of IS:9833 - 1981.with min. three coats wherein each coat shall be 125 microns.

4.70. ACOUSTIC TILES

Acoustic tiles shall be of a design and manufacture approved by the Employer's Representative and shall be bonded to ceilings in accordance with the manufacturer's details. They shall have glass wool backing resin bonded to grade RB2 and be fixed on timber or aluminium scantlings.

4.71. INSERTS, BOLTS ETC.

Fabricated pipe, moulded cast or fabricated frame insets, bolts plates etc. shall be provided in masonry and concrete works as required and shall b embedded in concrete with min. 450 mm baove the finshed level. It is imperative that all inserts, bolts, fixtures and fittings shall be provided in their position very accurately. Such inserts and bolts shall be fixed by use of templates. If as a consequence of negligence on the part of the Contractor, the inserts, bolts, fixtures fittings etc. are out of alignment, the Contractor shall make arrangements to have the inserts and bolts removed and refixed in their proper position as directed by the Employer's Representative.

4.72. WOODWORK IN DOORS, WINDOWS, PARTITIONS. LOUVRES, RAILINGS. ETC.

Wood used for all work shall be of approved quality of teak wood and properly seasoned by at least 6 months air drying, suitable for joiner's work, should be of natural growth, uniform in texture straight grained, free from sapwood dead knots, open shakes, boreholes, rot, decay and all other defects and blemishes.

Propoer pest control for the soil shall be done to prevent damage by termites.

The thickness specified for joiner's wrought timbers are, unless otherwise specified, prior to planning and 3mm will be allowed from the thickness stated for each wrought faces.

The joints shall be pinned with hard wood pins and put together with white lead. Jointing shall be by means of mortice and tennon or dovetailed joints, as approved by the Employer’s Representative.

Any joiner's work which shall split, fracture, shrink or show flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship, shall be removed and replaced with sound material at the Contractor's expense.

Doors, windows and ventilator frames shall be rebated. All dimensions shall be as approved. The top framing member of doors and top and bottom framing of windows and ventilators shall project about 150 mm in brickwork. The verticals of door frames shall project about 50mm below finished floor. Surface coming in contact with brick work shall be painted with bitumen as directed by me Employer’s Representative. Each of the door and window frames shall be provided with 3 Nos. M.S. 225 mm x 25 mm x 6mm flat split hold-fasts on each side. These hold-fasts shall be embedded in masonry or concrete work. The work shall conform to IS: 4021.

Panelled doors shall comprise a 250 mm wide bottom rail, 150 mm wide middle rail and all other rails, middle top and vertical 100 mm wide. All rails shall be 40 mm thick. Panels shall be 20 mm thick. The panelled doors shall have minimum of 3 panels.

The workmanship of all door shutters shall conform to the requirements of IS: 1003 (Parts 1 & 11) and IS: 2202 (Part I). If required, flush door panels shall be tested as per IS: 4020. Flush doors shall be of 35 mm thick solid core.

All doors shall have 15 mm thick, 40 mm wide teak wood architraves on both sides. Railing and architraves shall conform to the shape as approved and fixed by means of screws (counter-sunk or otherwise) or bolts.

Woodwork shall not be painted, oiled or otherwise treated before it has been approved by the Employer’s Representative.

The whole of the woodwork shall first be treated with two coats of anti-termite wood preservative chemicals of an approved make. All the wood shall thereafter be applied with primary coat of paint. The application of primer shall not be done within 24 hours of the application of the second coat of anti-termite treatment.

The doors shall have the following fixtures.

a) Single Leaf Doors

i) Heavy duty railway type butt hinges of oxidized brass, 150 mm long - 3 Nos.
ii) Godrej 6 lever mortise lock with lever handles on both sides - 1 No. (chromium plated brass)
iii) Tower bolt 300 mm long -1 No. (Chromium plated brass)
iv) Door stop - 1 No. (CP brass with rubber stopper)
v) Door Closer - 1 No. (heavy-duty hydraulic pipe)

b) Double Leaf Doors

All material shall be same as for single leaf doors

i) Heavy duty railway type hinges 150 mm long - 6 Nos.
ii) Aldrop - 1 No. (300 long)
iii) Tower bolls 300 mm long - 2 Nos.
iv) Pull handles - 4 Nos. (CP brass 150 long)
v) Door stops - 2 Nos.
vi) Door Closer -1 No.

Where the single leaf doors are 1200 mm wide the number of hinges used shall be four. Similarly, if the height of the door exceeds 2200 mm, the number of hinges shall be suitably increased. The doors shall be provided with parliamentary type hinges, wherever required.

Door closures shall be of heavy duty hydraulic type.

4.73. GLAZING FOR DOORS. WINDOWS AND VENTILATORS

a) Glass in general

Glass shall conform to the requirements of relevant IS codes and shall be free from bubble, smoke wanes, air holes, scratches and other defects and shall be cut to fit the rebates with due allowance for expansion. Glass which does not have uniform refractive index or which is wavy shall not be used.

b) Sheet Glass

Sheet glass shall be flat, transparent and clear as judged by the unaided eye. It shall be free from cracks. Sheet glass shall be of B quality or ordinary quality and the thickness shall be as specified. Sheet glass used for glazing in building shall conform to IS: 1761.

c) Wired Glass

All wired glass shall be 6 mm thick, polished Georgian or equivalent, with both faces ground and polished. The glass shall conform to IS: 5437.

d) Glazing

Putty for glazing to wood shall be prepared in accordance with IS: 1635. Glazing work in buildings shall conform to IS: 3548. Compound for glazing to metal is to be approved special compound manufactured for the purpose.

4.74. METAL DOORS AND WINDOWS

a) Aluminum Doors, Windows and Screens

All extruded sections used in work of aluminum doors, windows etc. shall be minimum 3 mm thick of Jindal or Hindal make or equivalent. All sections shall be aluminum anodized in matt or polished finish as directed. Aluminum doors, windows etc. of only approved manufacturers shall be used. The aluminum doors and windows shall conform to IS: 1948. Fixing of all aluminum doors and windows shall be carried out through the agency of manufacturers as per their specifications. Aluminum doors and windows shall be completely water tight.

The aluminum windows shall have either side projected or top projected shutters as specified to facilitate the cleaning of glasses. In case of side hung windows friction hinges shall be used, with stainless steel pins, Centre hung ventilators shall be hung on two pairs of cup-pivots of aluminium alloy or brass or bronze pivots chromium or cadmium plated.

Glass panes shall be free from flaws, speck or bubbles and shall be with properly squared corners and straight edges.

Following fixtures and fittings shall be provided :

For Doors

i) Two floor springs of suitable make such as Everite, Prabhat etc. or equivalent having double action spring,

ii) Each door leaf shall be fitted with two Nos. of suitable size of aluminium anodised handles from extruded tube of 100 mm x 50 mm minimum,

iii) One leaf out of two shall be fitted with tower bolt at top or bottom of 230mm size of chromium plated brass,

iv) 6 lever brass lock concealed in section tube and openable from both sides with two keys,

v) 1 door closer of heavy duty hydraulic type for each door leaf.

For Windows

One opener, one handle and 15 cm. long tower bolt of brass, chromium plated.

b) Steel Windows. Ventilators and Doors

Steel windows, ventilators and doors, including folding doors shall be supplied complete with frames and fitted with standard fixtures such as hinges, locks, bolts stoppers, handles as necessary.

Steel used in fabrication of windows and doors shall have a minimum thickness of 3 mm. There shall be no distortion in the frames. If steel doors are provided they shall be propoerly powered coated to prevent corrosion.

The whole frame with the exception of lugs and external faces of channels shall be painted after manufacture as per specifications.

c) Vehicular Doors

Vehicular doors shall be of mild steel construction not less than 1.25 mm thick and shall be of the roller shutter or concertina type as specified. The doors shall be supplied by a reputable manufacturer to the approval of the Employer's Representative and shall include a wicket door where specified. Doors shall be delivered to site painted with one coat of approved primer. After installation any damage to the paintwork shall be touched up and final painting will be carried out when approved by the Employer's Representative. Doors shall be smooth operating, capable of opening and closing by one man and shall be fully weatherproof when closed. They shall be supplied complete with secure locks including locks to the wicket doors where appropriate. Slats for the rolling shutters shall be in one piece and be made of heavy gauge steel sheets minimum 1.25 sq. in thickness. A cylindrical hood shall be provided on the top to enclosed the shutter when it is open.

5. GRAVEL IN UNDER DRAINS

The gravel/ metal shall be sound, durable tough clean chemically stable of 20 mm single sized which will not become powdery under loads and in contact with water. The gravel shall be free from soft thin, elongated or laminated pieces and vegetable or other delicious substances. The gravel shall be spread and thoroughly compacted in layers of 150 mm taking care that it does not get crushed.

4.78 WATER SUPPLY AND SANITARY WORKS - GENERAL

All plumbing works shall be carried out through a licensed plumber and the pipes and fittings shall be as per the requirements of the Municipal water bye-laws. The Contractor shall get the pipes and fittings work done to the entire satisfaction of the Employer's RepresentativeThe Contractor shall submit the name of the licensed plumber to whom the work is to be entrusted for approval of the Employer's Representative.

a) Sheet Lead for Flashing

The lead shall be new lead in accordance with IS: 405. Unless otherwise specified all lead shall weigh 200 N/m2. When laying lead care shall be taken to ensure that there is provision for expansion and contraction. No solder shall be used except where it is unavoidable.

b) Copper Tubing

Copper tubing shall be light gauge solid drawn seamless copper in accordance with IS: 5493. Brass of gunmetal fittings of the non manipulative compression joint type or capillary fittings shall be subject to the approval of the Employer's Representative. Copper tubing shall be fixed at not greater than 1.5 m centres with cast brass pipe brackets or other approved fasteners.

c) Galvanised Steel Tubing

Galvanised mild steel tubing and fittings shall be supplied by an approved manufacturer with screw and socket joints, tested hydraulically to a pressure of 48 bar. Pipes shall be

secured to structures at not more than 1.5 m centres with galvanized malleable cast iron brackets.

d) Fixtures and Valves

All fixtures and valves shall be of types approved by the Employer's Representative and in accordance with IS: 6157. Stop valves which arc generally concealed shall be made of brass or gunmetal. Stop cocks which are exposed and bid and pillar cocks attached to sanitary fittings shall be brass or gunmetal bodies chromium plated and market! "hot" or "cold" as required. Ball valves shall be brass in accordance with IS: 1703.

4.79 LAYING OF DRAINS

Before laying the drains the centre of each manhole shall be marked by a peg, or otherwise, as determined by the Employer's Representative. The Contractor shall then dig holes for setting up two posts (about 100 mm x 100 mm and 1,8m long) at each manhole at nearly equal distance from the peg and at sufficient distance therefrom to be well clear of all intended excavation. A sight rail shall then be fixed level against the posts and perpendicular to the line of excavation. The posts shall be erected in such a manner that they remain clear of all the other excavation trenches if any, converging on the manhole. The sight rails shall not be in any case more than 30 metres apart and intermediate rails may be erected if necessary.

Boning rods shall be prepared from timber section 75mm x 50mm in various lengths, each length being a multiple of half a meter and with a fixed tee head about 300 mm long. The boning rod shall be marked on both sides to indicate its length. According to the circumstances of each case, a suitable length of boning rod shall first be determined and thereafter markings shall be done on both posts or walls or fences to which the sight rails are fixed. These markings shall be at the level obtained by adding the invert level of the drain at the position of the sight rail and the selected level of the boning rod.

The sight rail (about 100mm x 25mm) shall then be screwed with top edge against the level marks. The centre line of the drain shall be marked on the rail, and this mark will denote also the meeting point of the centre lines of any converging drains. A line drawn from the tope edge of one rail to the top edge of the next rail will be vertically parallel with the invert of the drain, and the depth of the invert of any intermediate joint may be easily determined by letting down the selected boning rod until the tee head comes in the line of bight from rail to rail.

The posts and rails shall in no case be removed until the trench is excavated, the drains constructed and permission given to proceed with the filling-in. All drainage pipes /downtake pipes shall cPVC.

4.80 FORMATION FOR DRAIN PIPES

The bottom of every trench shall have a true grade throughout and shall be made in perfect straight lines. In case any loose, soft or bad ground is met with, it shall be excavated to a solid foundation and be filled up to the invert level of the drain sewer with concrete or otherwise as directed by the Employer's Representative.

The floor of every drain trench pit shall be formed for receiving the socket of the pipes and a mass of clay shall be placed all around every joint of the drain.

In excavating any trench, the materials forming the surface of any road, footpath, garden or field shall be kept separate and preserved for re-use at the surface when the trench is filled up. Before any road metalling is reused it shall be carefully shifted.

4.81 LAYING OF DRAIN PIPES

In laying the drains, care shall be taken that they are laid perfectly true to the grade and as far as possible straight from point to point of the manholes, vents or lamp holes and that all pipes are carefully and solidly packed underneath so as guard against subsidence or fracture of the pipes.

The drainage line shall be in uPVC pipes of approved make. The line shall be laid true to gradient in the underground portion. Where the pipeline is above ground, cast iron pipes shall be used. The pipes, bends and other specials in the superstructure work shall be laid vertical and fixed properly to the satisfaction of the Employer's Representative. The vent pipes shall be raised to about 200 cm above the terrace floor level. All pipes in trenches less than 1.5 m and over 4.5m deep and those in loose grounds and under-roads shall be protected and encased with concrete of grade M-15 all round.

4.82 JOINTING OF PIPES

The joints of cast iron shall be done in the manner described below:

Before treating the joint with cement sand mortar it shall be cleaned and moistened with water. The joint shall then be filled with a mixture of 1 part of cement and three parts of clean fine sand, with just sufficient water to have a consistency of semi dry condition. The mortar is forced into the joints and well rammed with caulking tool until the whole space round the spigot and the socket is filled and the joints shall then be finished off with a splayed fillet sloping at 45 degrees to the sides of the pipe. The shaft of the pipes entering or leaving the manhole shall have a splayed fillet or neat cement laid around the same extending outside the plastering of the manhole by 75mm.

Care shall be taken after the joints are made to see that the pipes are not moved or shaken before the cement has thoroughly set, and that they are watertight.

After the joints have thoroughly set, the Employer's Representative may inspect the joints, and if has any doubt as to their soundness, he may require, the Contractor to cut open and clear away the cement of any joint that he may select, and to make good the same at his expense. Normally he may not be required to open more than one joint in 20 metres of pipe laid. If however effects are found on such opening, the Employer's Representativemay direct him to open as many joints as he may deem necessary. The joints, made on any one day will not as a rule be inspected until the following day so that

the cement may have sufficient time to set, well before being covered up. For joining of PVC pipe refer Section-II of Volume-2, Employers Requirement.

4.83 REFILLING OF THE TRENCHES

After the foundations of any buildings or other work have been completed or the sewer or drain pipes have been laid and jointed or the inspection chamber manholes and vents completed and as soon as the joints have been inspected and passed by the Employer's Representative, the trenches shall be re-filled with the materials taken there from or as not to disturb, break or damage the jointed pipes. Immediately the finest selected material shall be put round the pipe or be thrown into the trenches until the same is completely protected by the finer material filling referred top above. The back filling shall be done in suitable layers and shall be rammed properly until it is thoroughly consolidated and watered in addition, if considered necessary by the Employer's Representative. Care shall be exercised so that the trenches are filled in solidly with selected material without voids under the pipes and that no damage is done to the pipe during the process of filling and consolidation.

4.84 MANHOLE

Manhole shall be constructed at places of every change of alignment of pipeline. The junction manholes shall be construction at places where two or more pipelines convergance at a point. Manholes shall be sufficiently spacious to accommodate a man to clean the same.

The manhole shall be circular and shall be construction in concrete only of required grade.

Where a pipe enters and leaves a manhole, on edge must be cut to proper form and laid around the upper half of pipe so as to form an arch. Where the depth of invert exceeds 1 meter below the surface of the ground, PVC encapsuled steps of approved pattern shall be built in at every four courses with additional hand irons.

The covers shall then be placed in position and the whole work shall be left neat and dry.

Covers and frames shall be of ductile iron and circular in pattern conforming to IS: 1726. They shall be coated with Dr. Angus Smith's composition. They shall be air tight, heavy pattern only, weighing about 150 kg to 180 kg.

4.85 SEPTIC TANKS AND SOAK AWAY PITS

The sewage from toilets shall be led to septic tanks prior to final disposal. The design and construction of septic tanks shall conform to IS:2470 (Part I). The floor shall be of cement concrete grade M20 and shall have a minimum slope of 1:10 towards the sludge outlet. The thickness of the floor at the lower most point shall be 150 mm. The walls shall be of such thickness as to provide adequate strength and water tightness. Walls built out of bricks shall be minimum 230mm thick and shall be plastered with 20mm thick 1:3 cement mortar of both inside and outside. Stone masonry walls shall be minimum 370mm thick. A

storage volume of sludge of 1 year shall be considered in the design. The effluent septic tank shall be taken to soak away pits which shall conform to IS: 2470 (Part 2).

4.86 C.I. NAHANI TRAP

The Contractor shall supply 8 cm (3") size C.I. Nahani traps, bends and pipes with 12.5 cm (5") C.I. grating of the best quality conforming to 1S:3989.

4.87 uPVC RAIN WATER PIPES

All downtake rain water pipes shall be of uPVC.

The size of the grating shall be slightly bigger than the external diameter of the pipe.

The cavity between brick masonry and the pipes etc. shall be made good in cement mortar, neatly after the fixing of the pipe.

In case of terraced roof, the cast iron grating shall be fixed at the inlet end of the pipes, properly secured in the wall to receive the rain water. The cast iron grating shall be recessed at a slightly lower level than the adjacent terrace floor level.

The pipes shall be fixed with nails driven through the holder battens fixed in the walls with the sockets facing up. Pipes and fittings shall be kept 12mm from the walls to facilitate cleaning, paintings etc. The joints shall be sealed with a few turns of spun yard soaked in bitumen or tar, which shall be pressed home with a caulking tool for 1/3" the depth of joints. More spun yam shall then be wound round the joint with cement mortar (1:3). At the ground level, they shall be supported on M-10 concrete blocks 300mmx300mm of sufficient height.

Pipes fittings and joints shall be tested for leaks as specified and defects, if any shall be rectified.

4.88. CAST IRON SOIL/ VENT/ WASTE PIPES WITH NECESSARY FIXTURES AND FITTINGS ETC.

The Contractor shall supply good quality pipes of approved make, including all fixtures viz. Tees, bends, etc. as required, free from cracks, flaws etc. Cast iron pipes shall be treated with Dr. Angus Smith's composition. The tolerance limits for various diameters for cast iron soil, waste and ventilating pipes shall be as set out in I.S.1729.

Care shall be taken to see that in case of soil or waste pipes the sockets shall be at the inlet end. In case of vent pipes, the sockets shall face up. The Cast iron pipes shall be fixed with nails driven through the holder battens fixed in the wall. Pipes and fittings shall be kept 12 mm from the walls to facilitate cleaning, painting etc. The joints shall be sealed with a few turns of spun yarn, soaked in bitumen or tar, which shall be pressed home with a caulking tool for 1/3 the depth of joints. More spun yarn shall then be wound round the joint with cement mortar (1:1).

The cast iron pipes shall be painted with one coat or red lead oil paint and two coats of anti-corrosive oil paint, of approved make and shade.

Pipe fittings and joints shall be tested for leaks as specified in 9.243 and defects if any, shall be rectified.

4.89. TESTING OF JOINTS OF DRAINAGE PIPES AND FITTINGS

The joints of drainage of pipes and fittings shall be tested by the Contractor as described below:

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be tested for gas tightness by smoke test under a pressure of 25mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke shall be produced by burning oily waste or tar paper in smoke machine. Chemical smokes are not satisfactory. If leaks are found during testing the joints shall be made good and the test repeated.

4.90. GULLY TRAPS

The Contractor shall supply and fix CI/DI gully trap outside the building and construct the brick masonry chamber including D.I. frame and cover around it as specified below.

The gully trap shall be set in M-10 cement concrete extending 30 cm beyond trap on three sides over which the brick masonry chamber shall be constructed in cement mortar (1:4). The building wall will be on the fourth side. Brick masonry shall have internal and external plaster 20mm thick in cement mortar (1:4). The C.I. cover including its frame shall be fixed in M-10 cement concrete 10 cm thick. The trap in the chamber shall be provided with a gratings.

4.91. INTERCEPTING SEWER TRAP

The Contractor shall provide the intercepting trap as approved by Employers representative.

The foundation concrete shall be in M-10 and shall be laid to a thickness of 250mm. The intercepting sewer trap shall be fixed into the extended portion of the foundation concrete on the main sewer side of the chamber. Brick masonry chamber of one brick thickness shall be constructed in cement mortar (1:4) with inside dimension of 90 cm x 90 cm and depth corresponding to the depth of the trap of the drain. During the construction, the rodding pipe of the trap shall be embedded in brick masonry. Channel in M-10 cement concrete shall be formed to lead away in the sewage. The floor of the chamber shall be sloping towards the channels. The brick masonry chamber shall be plastered on both sides in 20mm thick cement mortar (1:4). The C.I. cover and frame shall be fixed in M-10 cement concrete 10 cm thick.

4.92. BITUMEN LAYER TO WATER CLOSET SLAB

A bitumen layer shall be provided over the water closet slab for making it waterproof. Bitumen shall have a penetration limited to 40 when tested in accordance with IS: 1203.

The exposed slab surface shall be thoroughly cleaned of all dirt, dust and loose material. The surface of concrete shall be dry. Bitumen shall then be applied at the rate of 2 kg/sq. metre at a temperature of not less than 121°C (250°F) evenly throughout and allowed to dry before laying brick bat coba.

4.93. COLOURED GLAZED EARTHENWARE WATER CLOSET PAN

The Contractor shall provide English type white glazed earthenware water closet pan conforming to IS: 2556 of the specified dimensions with cast iron high level flushing cistern and other flushing accessories and necessary pipe connections up lo the soil and vend pipes fixed on the outside of wall. All the materials shall be of approved make. The Contractor shall obtain the prior approval of the Employer's Representative before fixing the pan and its accessories into place.

The pan shall be placed into position with the trap jointed in cement mortar (1:1) and the connecting pipes duly connected including the 32 mm diameter lead or galvanized iron pipe from the flushing cistern.

Brickbat cement concrete 1:2:4 shall be cast as specified by the specialist waterproofing agency in the fully water closet area and pressed all around the embedded surface of the pan and fittings and pipes to get solid embedding without any hollows. The pan be fixed at a slightly lower level than level of the general flooring which shall slope on all sides towards the pan. If the pan is damaged while handling or fixing, it shall be replaced by the Contractor at his own cost. The flushing cistern shall be fixed on two cast iron or mild steel cantilever brackets fixed in the wall at the height specified or as directed by the Employer's Representative.

The lead or galvanized iron flushing pipe shall be bent leaving a straight length of about 30 cm at the top and the lower portion after the bend shall be lowered into a recess left out in the wall and shall be concealed in the plaster. The whole installation shall be tested for leak-proof joints and satisfactory functioning.

The cistern brackets and all the exposed pipes shall be painted with a base coat of zinc rich primer and two coats of enamel paint of approved make and shade.

4.94. COLOURED GLAZED EARTHERNWARE URINAL

The Contractor shall provide white coloured earthenware flat back urinals or approved make conforming to IS:2556 including high level automatic flushing cistern of capacity as per 1S:2326, and a 'P' trap with vent extension. The urinal shall be securely fixed to the wall with the top of bowl 65 cm from the floor or such distance as may be directed by the Employer's Representative. All the pipe connections such as water connections from the cistern to the urinal with 20mm diameter main and 15mm diameter branch C.I. pipes and

32mm diameter lead waste pipe upto C.I. waste shaft on the outside wall shall be carried out as required. Holes made in wall shall be made good in cement mortar (1:4).

4.95. COLOURED GLAZED EARTHERNWARE WASH BASIN

Coloured glazed earthenware wash basin conforming to IS: 2556 including all necessary fixtures and pipe connections upto the outside the face of the wall, all of approved make and quality shall be provided and fixed at the location and level specified or as directed by the Employer's Representative. The wash basin shall be supported on a pair of rolled steel or cast iron cantilever brackets embedded in the wall or fixed to the wall with wooden cleats and screws. The height of the top of the basin from the floor shall be 75 cm unless otherwise directed by the Employer's Representative.

The waste pipe shall be of 32mm diameter galvanised iron and shall be provided as required upto a length of one meter with lead or nickel plate G.I. 'P' trap with rubber plug. The wash basin shall have G.I. supply pipe of 15mm diameter stop cock No. I and 15mm swan nickel plate tap. If holes are not left in the wall initially, they shall be cut and the cavity surrounding the drain or water pipes made good after fixing of the pipes.

4.96. WHITE WASH

Walls shall be thoroughly cleaned of all dirt and loose particles etc. before whitewash is applied. Inequalities and holes shall be filled up with gypsum which should be allowed to set hard. Whitewash shall be of ordinary fat lime and of a good quality. It shall be slaked with an excess of water to the consistency of a cream and allowed to remain under water for 2 days. It shall then be strained through a cloth and 2 kg of clean gum added for every cubic metre if lime ready for white washing.

Each coat is to be applied with a brush spray. It shall be laid with a stroke of the brush from the top downwards, another from bottom upwards over the first stroke and similarly, one stroke from the right and another from the left over the first brush before it dries. Three such coats shall be applied.

4.97. PAINTING

a) General

Employer's Representative's approval shall be obtained before commencing the painting work. All paints and preserves shall be of approved make and colour and their application shall conform to the manufacturer's instructions. Where more than one undercoat is specified it shall be applied in coats of distinctive tints. Workmanship shall conform to the requirements of IS: 2395.

Unless the manufacturer's instructions state otherwise 48 hours drying time shall elapse between successive applications of any primer and 24 hours between applications of all

subsequent coats. The surface of bituminous paints shall be left at least 3 days before further handling.

No paints in any coat shall be applied until the Employer's Representative is satisfied that the surface is clean and dry, and that any previous coat is satisfactory and has hardened adequately. When a surface has been approved, it must be painted immediately. Paintwork shall be rubbed down with a glass paper between coats. No paint shall be applied to a surface which is damp, dirty or otherwise inadequately prepared.

b) Concrete, Brickwork and Plaster

Where specified to be painted, concrete and plaster shall be rubbed smooth and any cracks, blister holes and other imperfections cut out, filled and made good. The surface shall be dried to the satisfaction of the Employer's Representative before painting is commenced and drying time of at least 28 days shall be allowed after laying brickwork and plaster or stripping formwork from concrete. The surface shall be brushed to remove any efflorescence and then painted with the following :

i) for interior brickwork and concrete, apply two coats of oil paint upto 1 meter height and for remaining part two coats of plastic emulsion paint over a coat of primer.

ii) for exterior brickwork and concrete, apply two coats of cement based paint over a coat of primer with a water repellent coat of siliconate solution of approved make.

Where painting with plastic emulsion is specified all uneven surfaces shall be made up by use of putty of appropriate quality after the surface has been thoroughly cleaned of all dust and dirt and sand papered.

c) Ironwork and Un-galvanised Steel Work

Structural steelwork shall be shot blasted to a "white metal" finish, and grease and oil removed prior to painting. Priming shall immediately follow blast cleaning and no cleaned surface shall be left unprimed for more than four hours. Only primers that chemically inhibit corrosion shall be used. Where the iron or steelwork is not in contact with raw or treated water, the primer shall be red lead complying with IS: 57. Where there is a possibility that the steel or ironwork may come in contact with water, the priming treatment shall be non toxic, zinc chromate or equivalent. Where it is anticipated that further welding will be required, an approved welding primer shall be applied to the areas to be welded and reprimed with the main primer when welding shall been completed. Primer coats shall not be less than 0.05 mm each. After erection, all damaged areas shall be made good, and reprimed where the original cost shall spread under the primer, the affected surface shall be cleaned down to bare metal to the satisfaction of the Employer's Representative and then reprimed.

Repainting shall be carried out as soon as possible after erection. If it is to be exposed to weather or condensation, it shall receive one further coat of primer.

Metalwork in intermittent or permanent contact with raw or treated water shall have two finishing coats of an approved coal tar pitch epoxy paint such as "Epilux 5" by Berger Paints, or equivalent. The total coating shall be minimum of 0.125 mm thick.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint conforming to IS: 2932 of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first coat of paint shall be applied by brushing and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer's Representative.

d) Galvanised Steelwork

Newly galvanised steelwork shall be primed with an etch primer such as calcium plumbate. Steelwork that has been galvanised for a long period so that the surface has oxidized adequately to allow adhesion of undercoats, need not have an initial coat of each primer.

After priming, galvanised steelwork in contact or intermittent contact with raw or treated water shall be given two coats of an approved coat of tar pitch epoxy paint such as "Epoxy 5" by Berger Paints, or equivalent. The total coating shall have a minimum thickness of 0.125 mm.

Protective coats for galvanised steelwork not in contact with water shall be:

i) one coat of micaceous iron oxide paint for interior galvanised steelwork.

ii) two coats of micaceous iron oxide paint for external galvanised steelwork.

Galvanised steelwork not in contact with water shall be finished with atleast one coat of gloss paint on top of approved undercoat.

e) Bituminous Surfaces

Metalwork items that have given a shop treatment of bituminous paint shall be painted with two coats of an approved anti-bleed paint before applying a coat of decorative finishing paint.

f) Aluminum Surfaces

Aluminum surface shall be worked clean, dried and thoroughly degreased before painting, by an appropriate solvent (such as one consisting of equal parts of white spirit and light solvent naptha). Flame cleaning shall not be permitted. The clean degreased surface shall be treated to ensure paint adhesion either by mechanical roughening, chemical adhesion, or etch primers or wash primers applied in strict conformity with the manufacturer's instructions or by other treatment approved by the Employer's Representative.

The pre-treated surface shall receive a priming coat with an inhibiting pigment containing not less than 20% by weight of fine chromate or other approved chromate in a suitable water-resisting vehicle.

The priming coat shall not contain any copper or mercury compounds and it shall also be free from graphite and carbonaceous materials and shall not contain any lead. Priming coat shall consist of a tung-oil phenolic-resin which is pigmented with equal parts of zinc tetroxy chromate and red iron oxide.

Aluminium surfaces in contact with concrete, or resting on pads on concrete, shall be painted with two coats bituminous paint, and the concrete surfaces shall also receive two coats bituminous paint.

g) Woodwork

Woodwork for painting shall be carefully rubbed down, treated with preservatives and knotted, stopped and primed in the shop. Care shall be taken to ensure that priming is thoroughly brushed into every part of the surface and in particular at end grains, joints and notches where two coats are to be applied. Primers for wood shall be of a standard equivalent to, or better than "Aluminium Wood Primer Sealer A 519-3697" by I.C.I Paints.

After the woodwork has been fitted and all defects in the surfaces have been made good and reprimed, one coat of approved undercoat shall be applied to internal surfaces and two coats to external; surfaces. An undercoat of quality equal to or better than "Delux Gloss Finish A365-line".

4.98. WATERPROOF CEMENT PAINT

a) Surface Preparation

The wall should be washed thoroughly with clean soft water and freed of all loose particles, dust, dirt, lichen, moss, efflorescence and lime wash by scrubbing with a wire brush. Inequality and holes shall be filled up with cement paste which should be allowed to set. To get even uniform mat finish it is necessary to keep the surface damp throughout the operation. In hot dry weather the wall should be frequently sprinkles with water to keep it moist.

b) Mixing the Paint

Loosen the contents by either rolling the drum or shaking the container before opening it. Take one measure of water by volume in a clean pot and add two volumes of approved quality waterproof cement paint conforming to IS: 5410. Stir well to make paste of high consistency then add one more measure of water constantly stirring the mixture. The final composition of water and paint is now 1: 1 by volume. Keep stirring the mixture all the time and use it up within an hour. Do not use the mix if it is left over for more than two hours.

c) Method of Application

Wet the surface by any convenient method. A small surface can be wetted by brush. When applying paint surface should be damp and not wet. While applying the first coat brush hared into the surface to cover pores and cavities to ensure better bond. Twelve hours after applying the first coat cure the surface by sprinkling the water. Before applying the second coat damp the surface and after the application of second coat cure it as directed above. In hot climate repeat curing at least twice at the interval of six hours for optimum best results.

d) Curing

After each application paint should be cured by sprinkling fine spray of water, normally after twelve hours when paint film is hardened satisfactorily. In summer when weather is hot, curing may be done little earlier. Water marks may be left over the surface if a stream of water is allowed to flow before the Paint film is hardened.

4.99. SILICON PAINT

a) Preparation

A solution for application shall be prepared from Syltrit 1722 or equivalent. The manufacturer's instructions shall be followed. This solution shall be prepared to a concentration of about 3% solids by mixing 1kg of water dilutable solution of sodium methyl siliconate with 9 kgs of water. Concentration higher than 3% solids are not recommended ad they may cause a white precipitate of sodium carbonate formation.

b) Application

A flooding technique should be used in applying to obtain the best penetration. When spraying, the solution should not be atomized or misted, but flowed on in a solid stream, with the spray gun held at distance just enough to eliminate foaming on the masonry surface. If foaming is allowed then certain visible marks might appear after application. The run down of 150 to 300 mm should be maintained with generous overlapping of passes. Dipping and brushing methods are also suitable. After application of the solution, the treated surface should be allowed to dry at least 24 hours to develop maximum water repellency. This interval may be shortened somewhat by force drying at temperatures to 30°C. Though this removes the water quickly, time must still be allowed for the curing. Reaction between the solution and the surface being treated. Until the reaction is complete

the applied film still remains water soluble and any rain falling during this time can wash it out. So application should be done in dry weather or at least in absence of rain and fog.

c) Spraying Equipment

Spraying equipment shall be hand operated stir up pump with stainless steel nozzle fitted with PVC or polyethylene delivery pipe. Components of the spraying, equipment that are in contact with the treating solution should be of black iron, mild steel, stainless steel, Teflon, PVC or polyethylene. They should not be of aluminium or galvanised steel.

d) Safety

The solution should always be applied in a liquid stream, not by misting or fogging. If misting occurs, avoid inhalation. Contact with eyes or skin should be treated immediately by flooding the area with large quantities of water for atleast 15 minutes.

4.100. BREAKING OF CONCRETE, BRICKWORK, BLOCKWORK AND STONE MASONRY

The Contractor shall demolish brickwork, blockwork, stone masonry or concrete either plain or reinforced, as indicated on the drawings. The waste material shall be at once removed from the location and dumped at a suitable location or transported and disposed off as directed by the Employer's Representative. The Contractor shall observe all precaution by way of necessary propping, strutting etc., to the satisfaction of the Employer's Representative, to ensure that the adjacent framework is not damaged. Any damage to any adjacent framework, brickwork or blockwork resulting from the negligence of the Contractor shall be made good at the Contractor's cost, to the satisfaction of the Employer's Representative.

4.101. LOCKS

All the doors and gates shall be provided with locks of approved quality available locally and in accordance with IS : 2209 or IS : 275 as appropriate. The locks shall be provided with keys in duplicate.

4.102. PROTECTIVE COATING TO PIPE LINES

In case of MS pipeline to be laid underground, before lowering into the trenches, the external surfaces of all pipes, specials and fittings shall be provided with 40 mm thick cement mortar coating by guniting, A length of 150 mm at each of the pipe strake shall be left ungunited to facilitate site welding. This portion shall be lined after laying, welding and field testing of the pipeline is completed satisfactorily. If the Contractor desires so, guniting the pipe externally after lowering them in the trenches will be allowed if the Contractor evolves a suitable method and the same is approved by the Employer's Representative. But, no extra payment will be made for widening or, deepening the trenches for this purpose. Where the pipes/specials are to be gunited externally or encased in concrete, the external surface of the pipe shall be given a coat of cement wash. The pipe surface shall be blast cleaned to the Employer's Representative's satisfaction. Immediately after the coating of the surface with cement wash.

Mix Proportion

The proportion of cement and sand shall be 1 to 3.5 by volume.

Thickness of Coating

The minimum thickness of the coating shall be 40 mm with a maximum plus tolerance of 3 mm.

Reinforcement

Welded fabric used as reinforcement shall conform to IS: 1566 or equivalent MS reinforcement, as directed by the Employer's Representative. The welded fabric used shall be bent to proper shape to conform to the surface of the fitting/special/pipe to be coated and shall be securely held 20 mms away from the surface of the pipe/special/fitting by means of spacer blocks made from cement mortar (1:1) and binding wire. Spacers shall be placed atleast 30 cm centre both ways. Adjacent sheets of fabric shall lap at least 80 mm and shall be securely fastened together by binding wire at intervals not exceeding 300 mm,

Preparation for Surfaces

The surfaces shall be thoroughly cleaned by sand or steel grit blasting before coating.

i) Hand Cleaning

Before blasting, all oil and greases on the surface of the metal shall be removed thoroughly by flushing and wiping using suitable solvents and clean rags. The use of dirty or oily rags will not be permitted. All other foreign materials shall be removed by buffing or by scrapping and wire brushing. After cleaning, the special shall be protected and maintained free of all oil, grease and dirt that might fall upon the plate from whatever source until the plate has received its cement mortar coating.

ii) Mechanical Cleaning

All metal surface shall be thoroughly blasted to bright metal. Blasted surfaces which acquire a coat of rust by buffing or wire-brushing or at the discretion of the Employer's Representative, shall be reblasted. Adequate air separators shall be used to remove all oil and free moisture effectively from the air supply 1o the blaster. Any plate showing pits or structural defects shall be kept aside pending examination.

iii) Rest preventing Coating

Immediately upon completion of blasting, surfaces at the end of fittings which are to be left bare shall be given a brush coat of a suitable rust preventive material. Rust preventing coating shall be applied and shielded and maintained during the subsequent application and curing of mortar lining and application of the exterior coating to protect from corrosion. Rust preventive material used shall be of such character that the quality of the weld and other functions of the steel plate will not be impaired by its presence.

Application of Mortar Lining by Guniting.

The pressure in the lower chamber of cement shall be sufficient to produce a nozzle velocity of 115tol 50 m/ second when a tip with 19 mm opening is used. The compressor used shall be of an adequate capacity to maintain a pressure of atleast 2.8 kg/sq cm at the gun end. The nozzle shall be held at such a distance (65 to 100cm) and position that the stream of flooding materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposits of loose sand shall be removed prior to placing and layer of gunite. Gunite shall be shot in one coat to the specified, thickness. Every precaution shall be taken to prevent the formation of sand pockets and if any develop, they shall be cut our and replaced with satisfactory machine placed material. No hand patching will be allowed. The Contractor shall apply the coating in such manner that no sloughing shall occur at any time during or following its application.

Gunite shall be placed in the top and sides of the pipe, then screeded to a uniform thickness and the ground lines or blocks removed. All rebound and waste materials shall then be removed by air blowing and gunite placed in the bottom of the fittings and screeded. When completed, the lining shall be concentric with the barrel of an even thickness. The entire surface shall then receive a final flash coat of gunite and shall be steel trowelled to a true surface equal in smoothness to the spun lining in such manner not to impair the bond between mortar and steel plate. The guniting and surface finishing shall complete in set and shall be applied continuously without the fuse of construction joints. In case, for any reason whatsoever, the cement does not adhere to the walls of pipes and sloughs off, swabbing the pipe with cement slurry shall not be permitted.

If for any reason it is necessary to interrupt the placing of the gunite for a length of time that will result in the material tasking a permanent set, a square shoulder shall be formed at the ends of the sections and/or elsewhere by shooting against backing up strip or by cutting back with a trowel or other suitable tools the irregular edges of the material last placed to a clean unbroken surface perpendicular to the face that will provide a suitable connection or construction joint between such material and then all material to be placed subsequently. When performing this work care shall be taken not to shatter or disturb the embedded wire mesh. Before placing fresh material against the surface of such joints, it shall be carefully cleaned and wetted to ensure a good bond between the fresh material and that previously placed. When gunite has hardened sufficiently, it shall be thoroughly wetted by sprinkling and maintained in a moist condition for fourteen days.

4.103. SUPPLY, FABRICATION & ERECTION OF STRUCTURAL STEEL

4.103.1. MATERIAL

Steel materials shall comply with the specifications laid down under the relevant Indian Standards and as called for in the specifications.

All steel material (plates and structural) covered in this Contract shall be supplied by the Contractor, in this connection the Contractor shall furnish to the Employer’s Representative duplicate copies of all mill orders covering the material ordered by him for this project and also the test reports received from the mills for the Employer’s Representative's check and information.

It is not the intention of the Corporation that all the steel materials to be supplied by the Contractor for the work shall be specially purchased from the rolling mills. The Contractor's stock material may be used, provided the mill test reported identified with the materials, satisfactorily demonstrate, the specified grade and quality. The Employer's Representative shall have the right to test samples to prove authenticity of the test certificates produced by the Contract or at the Contractor's cost. All steel materials shall be in sound, condition, of recent manufacture, free from defects, loose mill scale, slag intrusions, laminations, pitting, flaky rust etc., and be of full weight or thickness specified. The length/ sizes of steel sections and plates shall be as supplied by the steel mills.

Unidentified stock material may be used, only with the prior permission from the Employer's Representative in writing, for short sections for minor importance or for small unimportant works and connections where, in the opinion of the Employer's Representative, the quality of such materials would not adversely affect the strength and/or durability of the structure. The Employer's Representativemay also permit use of such material for other works, if adequate random samples taken out and tested demonstrate conformity with the specification and requirement for the work in view.

4.104. SUB-STITUTIONS

Where the Contractor, in order to accommodate his materials in stock, desires to substitute structural steels or plates for the sizes shown on approved drawings, such substitutions shall be made only after authorization in writing by the Employer's Representative. The Employer's Representative may also direct that substitution be made, when considers such substitutions to be necessary.

4.105. FABRICATION

a) General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined true and square where so specified. All holes and edges shall be free of burns. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise directed/approved, reference may be made to the American Institute of Steel Construction Manuals for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

b) Connections

Shop connections shall be effected either by welding, riveting or bolting as specified or as indicated on approved drawings. Type and quality of bolts shall be in accordance with IS stipulations. However, standards MS bolts to IS: 1363 may be used for field connections for light members such as purloins, staircase stringers, hand railings, and landing beams.

Where necessary, tapered washers or flat washers or spring washers shall be used under with nuts or the heads depending upon whether the nuts or the heads are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be atleast three limes the thread pitch. In all cases where bearing is critical, the unthreaded bolt shall bear on the members assembled. A washer of adequate thickness shall be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose. All bolts, nuts, washers, rivets, electrodes, screw, etc., shall be supplied/brought to site 10 % in excess of the requirement in each category and size. All members likely to collect rainwater shall have drain holes provided. Not more than one shop splice shall be provided to make up the full length of a member.

c) Straightening

Rolled material, before being worked, shall be straightened, unless otherwise specified. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mangle or leaving rolls and structural shapes by the use of mechanical or hydraulic bar/ section straightening machines. Heating or forging shall not be resorted to without the prior approval or directions of the Employer's Representative in writing.

d) Cutting

Cutting may be shearing, cropping, sawing or machine flame cutting if permitted by the Employer's Representative. All re-entrant comers shall be shaped notch-free to a radius of atleast 12mm. Sheared or cropped edges shall be dressed to a beat workmanlike finish and shall be free from distortion and burrs. The kerf on machine flame cut edges shall be removed. Where machine flame cutting is permitted for high tensile steel, special care shall be taken to leave sufficient margin and all flame hardened material shall be removed by machining/ edge planning. Hand flame cutting shall be undertaken only if so permitted by the Employer's Representative and shall only be carried out by and expert in such work. Hand flame cut edges shall be ground smooth and straight.

e) Rolling and Forming

Plates, channels, RSJ etc. for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection on site.

f) Punching and Drilling

Holes in secondary members such as purlins, girts, lacing bars, etc may be punched nail size through materials not over 12 mm thick. Holes must be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances, such parts shall be first assembled, then tightly clamped together and drilled through. Sub-punching may be permitted before assembly, provided the holes are Punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not, even in such case, exceed 16 mm. When batch-drilling is carried out in one operation through two or more separable parts, these parts shall be separated after drilling and the burrs removed. Holes for turned and fitted

bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to H 8 tolerances specified in IS: 919. Where reamed members are taken apart for shipping or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No inter-change of reamed parts will be permitted, Poor matching, over-drilling, and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

(g) High Strength Friction Grip Bolting

High strength friction grip bolts and nuts shall conform to IS: 3757. Installation of high strength friction grip bolts in joints shall comply with IS: 4000. The diameter of the bolt hoes must not be more than 1.5mm larger than the nominal diameter of the bolt. All contact surfaces in a connection including those associated with the not heads, nut in a washers, shall be free of scale, burrs, dirt and other foreign matter tending to inhibit uniform sealing of the joint components/ nuts and washers need not be removed. All fasteners in a joint shall be tightened to a tension equal to or greater than the specified proof load show in the following table, either by the calibrated method or the turn-of-nut method.

Bolt Size	Proof Load (Kg)	
	Bolts to I.S. 37S7-BG	Bolts to I.S. 3757-10K
M16	9120	10790
M20	14700	17150
M22	18180	21210
M25	21180	23710
M27	27450	32130
M33	41640	48580

Tightening may be achieved by use of pneumatic powered impact wrenches, long-handled manual torque wrenches with or without torque multipliers or electric wrenches. A hardened washer shall be placed under the element being turned. Bolts shall be tightened at the most rigid portion of the joint, proceeding towards the free edges.

When using the calibrated wrench method, adjustable power impact wrenches and manual torque wrenches shall be calibrated to induce bolt tensions of 5 percent in excess of the proof load values for each size of bolt to be used in installation. Every wrench shall be calibrated by having it tighten a minimum of three bolts of the same diameter, in a hydraulic tension measuring device. Calibration shall be repeated whenever a wrench is required to tighten a different size bolt, or atleast once each working day if there is no change in the bolt size. Impact wrenches shall be set so as to shall or cut at the torque effort corresponding to the prescribed fastener tension. When manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be determined and taken as the job standard. Torque measurements shall be read while the turned element is in tightening motion. As subsequent tightening of bolts in any particular assembly is liable to loosen bolts already tightened, all bolts must be "Touched up".

When using the turn of nut method a sufficient number of bolts must initially be 'snugged up' to bring the connection components into full contact, by either a standard power impact wrench or an ordinary spud wrench. Snug tight condition shall indicate the point at which the turned element ceases to rotate freely and the impact wrench begins to impact or if a common spud wrench is employed, snug tightness shall mean the position resulting from the full effort of a man. Subsequently, the remaining bolts in the joints shall also be brought to snug tightness. All nuts and projecting bolt points shall be matchmarked in this starting position and all bolts in the joints relevant specifications for the bolt length and type of connection proceeding in an orderly fashion from the most rigid portion of the joint, towards the free edges.

If the finger-tight condition is used as a starting point extra full turns shall be taken to correspond to one-half turn from the snug tight position.

Load indicating bolts or load indicating washers may be used if so approved by the Employer’s Representative in writing.

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

(h) Welding

Electrodes for shielded-arc manual welds shall comply with the requirement of IS: 814, and shall be approved make.

The electrodes for manual arc welding shall be suitable for use in the position and type of work, as laid down in the above specifications and as recommended by the manufacturers. Electrodes classification group 1 or 2 as given in IS: 814 shall be used for welding steel conforming to IS: 2062 and electrodes shall conform to IS: 1442 for steel conforming to IS: 8500. Joints in materials above 20 mm thick and all-important connections shall be made with low hydrogen electrodes.

The wire and flux combination for submerged arc welding shall conform to the requirements for the desired application as laid down in IS: 3613. The weld metal deposited by the submerged arc process shall have mechanical properties not less than that specified by the relevant standard.

Electrodes flux covering shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Covered electrodes for manual-arc welding shall be properly stored in an oven prior to use in a manner recommended by the manufacturer and only an hour's quota shall be issued to each welder from the oven.

Electrodes larger than 5 mm diameter shall not be used for root-runs in butt welds.

Welding plant and accessories shall have capacity adequate for the welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality. The Contractor shall maintain all welding plant in good working order. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequately earthed and adequate means of measuring the current shall be provided.

All welds shall be made only by welders and welding operators who have been properly trained and previously qualified by tests to perform the type of work required as prescribed in the relevant applicable standards.

All welds shall be free from defects like blow holes, slag inclusions, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

Fusion faces and surfaces adjacent to the joint or a distance of atleast 50 mm on either side shall be absolutely free from grease, paint, loose scales, moisture or any other substance which might interfere with welding or adversely affect the quality of the weld. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations, etc. Preparation of fusion faces shall be done in accordance with the approved fabrication drawings by shearing, chipping, machining or machine flame cutting except that shearing shall not be used for thickness over 8 mm.

In the fabrication of cover-plated beams and built up members all shop splices in each component part shall be made before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

Members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated by more than 3 mm. If the separation is 1.5 mm or greater the fillet weld size shall be increased by the amount of separation. This shall only apply in the case of continuous welds. The fit-up of joints at contact surfaces which are not completely sealed by welds shall be close enough to exclude water after painting.

The separation between the two surfaces of lap joints and butt joints with backing plate shall not exceed 1.5 mm. Abutting parts to be butt welded shall be carefully aligned and the correct root gap maintained throughout the welding operation. Misalignments greater than 25 % of the thickness of the thinner plate or 3mm,whichever is smaller, shall be corrected and in making the correction the parts shall not be drawn into a slope sharper than 2° (1 in 27.5).

Pre-qualified welding procedures recommended by appropriate welding standards and know to provide satisfactory welds shall be followed .A welding procedure shall be prepared by the Contractor and submitted to the Employer's Representative for approval before start of welding. This shall include all details of welding procedures with reference to provisions of IS: 9595 and IS: 4353.

Approval of the welding procedure by the Employer's Representative shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

Submerged arc, automatic or semi-automatic welding shall generally be employed. Only where it is not practicable to use submerged arc welding, manual arc welding may be resorted to.

Voltage and current (polarity of direct current is used) shall be set accordingly to the recommendations of the manufacturer of the electrode being used and suitability of thickness of material, joint form etc.

The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided.

No welding shall be done when the surface of the member is wet, not during periods of high wind unless the welding operator and the work are properly protected.

In joints connected by fillet welds, the minimum sizes of single fillet welds or first runs and minimum full sizes of fillet welds shall conform to the requirements of IS: 816 and IS: 9595.

All complete penetration butt welds made by manual arc welding, except when produced with the aid of backing material or welded in flat position, from both sides in square-edge material not over 8mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is a started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross section.

Butt welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where abutting parts are 20 mm or more than in thickness, run-on and run-off plates with similar edge preparation and having a width not less than the thickness of the thicker part jointed shall be used. These extension pieces shall be removed upon completion of the weld end, the ends of the weld made smooth and flush with the abutting parts. Where the abutting parts are thinner than 20 mm, the extension pieces may be omitted but the ends of the butt welds shall then be chipped or gouged out to sound, metal and side welded to fill up the ends to the required reinforcement.

Each layer of a multiple layer weld except root and surface runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

No welding shall be done on base metal at a temperature below 5°C. Base metal shall be preheated to the temperature given in the table below prior to tack welding or welding. When base metal not otherwise required to be preheated, is at a temperature below 0°C, it shall be preheated to at least 20°C prior to tack welding or welding. Preheating shall bring the surface of the base metal within 75 mm of the point of welding to the specified preheat temperature, and this temperature shall be maintained as minimum inter pass temperature while welding is in progress.

Table 4.21

Thickness of the thickest part at point of welding	Minimum preheat & inter pass temperature			
	Other than low-hydrogen welding electrodes		Low hydrogen welding electrodes	
	IS: 2062 Steel	IS: 8500 Steel	IS: 2062 Steel	IS: 8500 Steel
Upto 20 mm incl.	None	Welding	None	10°C
Over 20 mm to 40 mm incl.	65°C	With this process not allowed	10°C	65°C
Over 40 mm to 63mm incl.	110°C		95°C	110°c
Over 63 mm	150°C		110°C	150°C

Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 75 mm and above.

Before commencing fabrication of a member or structure in which welding is likely to result in distortion and/or locked up stresses, a complete programmed of fabrication, assembly and welding shall be made and submitted to the Employer's Representative for approval. Such a programme shall include, besides other appropriate details, full particulars in regard to the following:

i) proposed pre-bending in components such as flanges and presetting of joints to offset expected distortion.

ii) Make up of sub-assemblies proposed to be welded before incorporation in final assembly.

iii) Proposed joint forms, classification of wore and flux or covered electrodes, welding process including fitting and welding sequence with directions in which freedom of movement is to be allowed.

iv) Proposed number, spacing and type of strong backs, details of jigs and fixtures for maintaining proper fit up and alignment during welding.

v) Any other special features like assembling similar members back to back or stress relief.

So desired by the Employer's Representative, mock up welding shall be carried out at the Contractor's cost to establish the efficiency of the proposed programme, with any modification suggested by the Employer's Representative, in limiting distortion and/ or residual stress to acceptable levels. Such modification will not relieve the Contractor of any of his responsibilities,

i) Inspection of Welds

All welds shall be inspected for flaws as described elsewhere under "Inspection".

In case the tests uncover defective work, the Contractor shall correct such defects at his own cost, and prove the soundness of rectified work.

The correction of defective welds shall be carried out as directed by the Employer's Representative without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Employer's Representative shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the Contractor's account.

j) Tolerance

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel. The acceptable limits for straightness (sweep and camber) for rolled or fabricated members are:

Struts and columns	-	L/1000 or 10 mm whichever is smaller
For all other members not Primarily in compression such Such as purlins, girts, bracing and the web members of trusses latticed girders	-	L/500 or 15 mm whichever is smaller

Where L is the length of finished member or such less length as the Engineer may specify.

A limit for twist prior to erection

In box girders & heavy columns	-	L/1500
Other members	-	L/1000

The twist of the member between any two sections shall be measured with the web vertical at one of the sections.

Tolerance in specified camber of structural members shall be ±3 mm.

Tolerance is specified length shall be as follows :

Type of member	Tolerance
A column finished for contact bearing	±1 mm
Other members (e.g. beams) under 10m	+ 0 & -3 nun
Other members (e.g. beams) under 10 m long and over	+ 0 & -5 mm

End of members

Beams to beam and beam to column connections - Where the abutting parts are to be joined by butt welds, permissible deviation from the squareness of the end is :

Beams upto 600 mm in depth -	1.5 mm
Beams over 600 mm in depth -	1.5mm every 600mm depth, to a max. of 3 mm

Where abutting parts are to be joined by bolting through cleats or end plates, the connections require closer tolerance, permissible deviation from the squareness of the end is :

Beams upto 600 mm in depth -	1.0 mm
Beams over 600 mm in depth -	1.0mm every 600 mm depth, to a max. of 2.0 mm

Butt Joints

For full bearing, two abutting ends of columns shall first be aligned to within 1 in 1000 of their combined length and then the following conditions shall be met:

i) Over at least 80 % of the bearing surface the clearance between the surfaces does no exceed 0.l mm

ii) Over the remainder of the surfaces the clearance between the surfaces does not exceed 0.3 mm
Where web stiffeners are designed for full bearing on either the top flange or bottom flange or both, at least half the stiffener shall be in positive contact with the flange. The remainder of the contact face could have a maximum gap of 0.25 mm.

Depth of Members

Acceptable deviation from the specified overall depth :

For depth of 900 mm and under	±3 mm
For depth of over 900 mm and Under 1800 mm	±5 mm
For depth of over 1800 mm and over-	+8 mm -5mm

Web Plates

An acceptable deviation from flatness in girder webs in the length between the stiffeners or in a length equal to the girder depth shall be 1 /150th of the total web depth.

Flange Plates

A reasonable limit for combined warpage and tilt on the flange of a built up member is l/200lh of the total width of flange or 3 mm whichever is smaller measured with respect to centerline of flange.

Lateral deviation between centerline of web plate and centerline of flange plate at contact surface, in the case of built up sections shall not exceed 3 mm.

End Milling

Column bearing on each other of resting on base plates and compression joints designed for bearing shall be milled true and square to ensure proper bearing and alignment. Base plates shall also have their surfaces milled true and square.

4.106. INSPECTION

The Contractor shall give due notice to the Employer's Representative in advance on the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the Employer's Representative's approval/inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Employer's Representative if it fails to be in proper condition or has fabrication inaccuracies which prevents proper assembly. No material shall be painted or dispatched to site without inspection and approval by the Employer's Representativeunless such inspection is waived in writing by the Employer's Representative.

Shop inspection by the Employer's Representativeor his authorized representative or submission of test certificate and acceptance thereof by the Employer's Representative shall not relieve the Contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which the

Employer may make because of defective or unsatisfactory material and / or workmanship.

The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. The Contractor's inspection work shall be under the control of a competent Chief Inspector whose primary responsibility is inspection, reporting to management and not to production departments.

For fabrication work carried out on site, the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Employer's Representative.

Inspection and tests on structural steel members shall be as set forth below:

a) Material Testing

If mill testing reports are not available for any steel materials the same shall be got tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

b) Test on Welds

Magnetic Particle Test

Where the root and intermediate passes of a weld are examined by magnetic particle testing, such testing shall be carried out throughout its entire length in accordance with IS: 5334 or ASTM specification E-I09. In the case of completed welds, such tests shall be carried out in accordance with IS: 5334 or ASTM specification E-109 or E-138 as decided by the Employer's Representative. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with permission of the Employer's Representative.

Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with ASTM E-165 or I.S. 3658. AI defects shown shall be repaired and rechecked.

c) Radiograph Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per IS:2595.

d) Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stage of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements indicated in the specification and approved drawings.

e) Inspection or Test Failure

In the event of any failure of members to meet an inspection or test requirement, the Contractor shall notify the Employer's Representative or his authorized representative.

The Contractor must obtained permission from the Employer's Representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Employer's Representative.

The Employer's Representativehas the right to specify additional inspection or testing as he deems necessary, and the additional cost of such testing will be borne by the Contractor.

The Contractor shall maintain record of all inspection and testing which shall be made available to the Employer's Representative or his authorized representative.

4.107. STAIRWAYS & INTERMEDIATE LANDINGS & GRATINGS

All stairways and intermediate landings shown and/ or listed on the drawings or specifications shall be fabricated as per specifications drawings as a complete unit and shall include grating treads, landings, hangers, brackets, struts, clips, bracings, etc. as necessary for erection. The gratings shall be capable of sustaining a minimum safe live load of 750 kg/sq metre of plan are unless otherwise specified or required and shall have a minimum thickness of 25 mm. Treads and landings shall be suitable for the prescribed ;loadings and be furnished complete with one piece standard non-slip abrasive nosing of approved type. The maximum width of openings in gratings shall not exceed 100 mm and the maximum spacing of bearing bars shall not exceed 40 mm. The minimum thickness of main bare shall be 5mm. Gratings shall be hot dip galvanised and painted. The grating pattern shall be approved by the Employer's Representative.

4.108. CHEQUERED PLATE

GRP Chequered plates used shall be minimum 6 mm thick and shall be capable of carrying a minimum live load of 750 kg/sq metre unless otherwise required. Chequered plate shall be fixed by 8 mm diameter non crossive steel screws with counter sunk heads at a maximum spacing of 400 mm. Members supporting the chequered plate shall have matching holes tapped in them. The chequered plate pattern shall be approved by the Employer's Representtaive.

4.109. DISSIMILAR METALS

The Contractor shall not use fixtures and fittings for metal work including pipe work, in which dissimilar metals are liable to lead to galvanic action when placed in permanent contact with each other. Mild steel surfaces in contact with aluminum alloy shall be galvanised or otherwise protected. Where faces of aluminum join, only aluminum bolts, nuts washers and screws shall be used. Aluminum shall be fixed to structures using galvanised mild steel bolts, nuts and screws, tufnol sleeves and washers.

4.110. GALVANISED STEELWORK

Galvanising shall be carried out in accordance with IS: 6159 and IS: 2629. All rough edges and burrs shall be neatly filed off, all holes required are to be drilled, and all fabrication shall be completed before the work is galvanised. No galvanised metal shall be painted until the Employer's Representative has inspected the coating.

4.111. ACCESS LADDERS

Access ladders shall be made of mild steel and galvanised as specified. Rungs shall be 20mm diameter.

Ladders shall be fixed at the top and the bottom and at intervals not exceeding 2.5m and the rungs shall not be less than 200 mm from the wall, secured by galvanised ragbolts of an approved type.

Ladders may also be fixed at the bottom by bending the stringers and bolting to the floor.

4.112. PROVIDING. HOISTING AND FIXING IN POSITION WATER STORAGE TANK

This item pertains to the provision and installation of the HOPE UV stabilised water storage tank including all necessary fittings.

The HDPE tank shall conform to IS: 12701. Galvanised iron pipes, ball cocks, stop taps, provided by the Contractor shall be approved by the Employer's Representative.

Unless other sizes are shown in the drawing galvanised iron pipes shall be (i) 25mm size for overflow, (ii) 38 mm size for scour, (iii) 50mm size for inter connection. These pipes shall conform to IS: 1239. Overflow pipe shall be provided with a brass mosquito proof coupling and galvanised iron plug for scour pipe.

4.113. MAKING OF MEMBERS

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20mm high and such optimum depth as to be clearly visible, even after a member is galvanised.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolts holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be on identical location. Members having length of 7m or more shall have the erection mark at both ends. In addition, colour code marking shall be clearly painted on the member in the manner specified.

4.114. ERRORS

Any error in shop work which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the Employer's Representative as defective workmanship. All charges incurred by the Corporation either directly or indirectly because of the poor workmanship will be deducted from the amount due to the Contractor before payment is made. In case the Employer's Representative choose to reject the material because of poor workmanship, the cost of all handling and returning the material of the Contractor, if he so desires shall entirely be borne by the Contractor. All the replacement materials shall be supplied free and in all such cases, the cost of handling, transporting and delivery to site also be borne by the Contractor.

4.115. PAINTING

Fabricated Steel material, where specified, shall be receive protective paint coating. All paint shall be of approved make and shade. The painting work shall be carried out as specified in Section 'G' - Building works to the complete satisfaction of the Employer's Representative.

4.116. HANDLING AND STORAGE

No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by the Contractor well before such excavation and/ or grading commence to a safe distance 1o avoid burial under debris.

Scratched or abraded steel shall be given a cost of primer for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/ corrosion and also from getting damaged by suitable coating.

4.117. ANCHOR BOLTS AND FOUNDATIONS

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed to ensure that the structures can be properly erected as specified.

Any discrepancy in the anchor bolts/ foundations shall be reported to the Employer's Representative.

Anchor bolts shall be provided with three nuts on upper threaded portion, one of which shall be used for leveling the column base to the required elevation and one will be a lock nut. All shim stock, required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good mild steel plates and shall be supplied by the Contractor at his cost.

All cleaning and preparing the foundation area shall be carried out by the Contractor at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and leveled as part of the work. All grouting under column base plates or beam bearing plates shall also be carried out by the Contractor.

4.118. ASSEMBLY & CONNECTIONS

Field connections may be effected either by riveting, bolting, welding or by use of high strength friction grip bolts as specified or required.

All welding shall be in accordance with IS: 816 and IS: 9595. All assembling shall be carried on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used top such an extent as to damage the holes. Size of drifts, larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the Employer's Representative.

Corrections of minor misfits and reasonable amount of reaming and cutting or excess stock from rivet shall be considered as a part of erection. Any error in shop which prevents proper fit on a moderate amount of reaming and slight chipping or cutting shall be immediately reported to the Employer's Representative.

4.119. ERECTION

All structural steel shall be erected as shown on the specification drawings and as per an erection scheme approved by the Employer's Representative. Proper size steel cable slings etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations etc., unless so permitted by the Employer's Representative in writing. The Contractor shall furnish the necessary non-inflammable staging and hoisting materials or equipments required for the erection work sand shall remove and take them away after completion of the job.

Structural steel frames shall be erected plumb and true. All steel column and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to tame care of all loads to

which the structure may be subjected. Such bracings shall be left in place as long as may be required for safety and stability.

As erection progresses, the work shall be securely bolt to take care of all dead load, wind, seismic and erection stresses.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Employer's Representative. No cutting, hating or enlarging of the holes shall be carried out without the prior approval of the Employer's Representative.

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer specified. Before paint is applied the surface shall be dry and free from dust, dirt, scale and grease. All surfaces in accessible after erection shall receive two coats of the approved paint before erection.

The Employer's Representative shall have free access to all parts of the job during erection and all erection shall be subject to his approval. In case of faulty erection all such dismantling and re-erection required will be at the Contractor's cost. No paint shall be applied to rivet heads of field welds or bolts until these have been approved by the Employer's Representative.

4.120. TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

Beams

Deviation in difference of bearing levels of beams from the true difference	Depth <1800 mm i 6 mm Depth > 1800 mm i 10 mm
Deviation in sweep of beams in the horizontal plane	1/1000 of span in mm subject to a maximum of 10 mm

Crain girders and rails

Shift in the centre line of crane rail with respect to centre line of web of crane girder	± 5 mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	± 5 mm
Differences in alignment of crane rail in plan measured between any two points 2 meters apart along rail	± 1 mm

Deviation in crane track with respect to true gauge

a)	For track gauges upto and including 15 metres	± 5 mm
b)	For track gauges more than 15 metres Where S in meters is true gauge	±5[5+0.25(5– 15)]
	Deviation in the crane rail level at any point from true level	1/1200 of the gauge distance or+10 mm whichever is less
	Difference in the crane rail actual levels between any two points 2 metres apart along the rail length	± 2 mm

Columns

Deviation of column axes at foundation top level with respect to true axes

a)	In longitudinal direction	± 5 mm
b)	In lateral direction	± 5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level ± 5 mm

Out of plumbness (verticality) of column from true vertical axis, as measured at column top

a)	For columns upto and including 15 m in height	± 1/1000 of column height in mm or ± 15 mm whichever is less
b)	For columns exceeding 15 m in height	± 1/1000 of column height in mm or ± 20 mm whichever is less

Deviation in straightness in longitudinal and transverse planes of column at any point along the height	+ 1/1000 of column height in mm or- 10mm whichever is less
Difference in erected position of adjacent pairs of columns along length or across width of building, prior to connecting trusses /beams with respect to true /distance	± 10 mm
Deviation in any bearing or seating level with respect to true level	± 5 mm
Deviation in differences bearing levels of a member on adjacent pair of columns both across and along the building	± 10 mm

Difference in levels between crane track rails at		
a)	Supports of crane girders	+ 15 mm
b)	Mid span of crane girders	+ 20 mm
Relative shift of crane fail surfaces at a joint in plan and elevation		2mm subject to grinding of surfaces for smooth transition
Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm		1/100 of track gauge S in mm subject to maximum of 20mm