

APCRDA
TECHNICAL SPECIFICATIONS (DRAFT)
FOR WATER AND WASTEWATER

EARTH WORK SPECIFICATION

1. General

The developer/ contractor shall furnish all tools, plant, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Employer's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes within the lead specified and leveling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Employer's Representative. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

Topsoil shall be stock piled separately for later re-use.

Clearing

The area to be excavated/ filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The

material so removed shall be disposed off as approved by the Employer's Representative. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

Excavation

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer's Representative, the work involved requires it to be carried out by manual methods.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the Contractor or such other lines and grades as may be agreed with the Employer's Representative. Rough excavation shall be carried out to a depth of 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete as approved by the Employer's Representative. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the drawings provided by the Contractor as agreed with the Employer's Representative. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with concrete of the same class as in the foundation resting thereon, upto the required elevation at no cost to the Employer. All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's Representative shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

Stripping Loose Rock

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Employer's Representative, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Employer's Representative, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

Excavation in Hard Rock

Excavation in hard rock shall be only by chiseling / Jack hammering or by drilling with mechanical brakers.

The rock shall be removed by wedging, pick, boring, heating and quenching or other approved non-blasting methods. All loose or loosened rock in the sides shall be removed by barring, wedging etc. No blasting is allowed.

Fill, Backfilling and Site Grading

General

- (a) All fill material shall be subject to the Employer's Representative's approval. If any material is rejected by Employer's Representative, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Employer's Representative after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Employer's Representative.

Material

To the extent available, selected surplus soils from excavations as approved by the Employer's Representative shall be used as backfill. Backfill material shall be free from

lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Employer's Representative. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed off as directed by Employer's Representative. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

Filling in pits and trenches around foundations of structures, walls, etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Employer's Representative. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Employer's Representative is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Employer's Representative.

Plinth Filling

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Employer's Representative may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlement at a later stage. The finished level of the filling shall be trimmed to the level/ slope specified.

Compaction of the plinth fill shall be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Employer's Representative. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Employer's Representative obtained prior to commencing filling.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Employer's Representative, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated, then filled and consolidated. At some locations/areas, it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

Sand Filling

Where backfilling is required to be carried out with local sand it 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. The surface of the consolidated sand shall be dressed to 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.

Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipe and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, moorum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

General Site Filling

Filling and compaction shall be carried out as specified under Clause 12.7 and elsewhere unless otherwise indicated below.

The fill shall be placed in layers not exceeding 150 mm and levelled uniformly and compacted as indicated in Clause 12.7 before the next layer is deposited.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. The fill will be considered as incomplete if the desired compaction has not been obtained.

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 material and make good the slip.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicated grades without further breaking. In such an 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 rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 ton roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

Fill Density

The compaction, where no higher standard of compaction is specified or shown on the drawings, shall comply with minimum 95% of maximum laboratory dry density as per IS 2720 (Part 8) at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

Timber Shoring

Timber shoring shall 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.

The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

In the 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's shall be subject to the approval of the Employer's Representative. In all other respects, the Employer's Requirements 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 excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

Dewatering

The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of

pumping shall be approved by Employer's Representative, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Employer's Representative to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Employer's Representative. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a build up of water in the opinion of the Employer's Representative obstructs the progress of the work, leads to insanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Employer's Representative, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Employer's Representative, details of his well point system including the stages, the spacing, number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

Rain Water Drainage

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Employer's Representative.

Site Filling

Sandfill

Sand fill shall be deposited to bring the grade level to the desired elevation after compaction of fill.

Sand fill shall be carried out in one of the following methods as specified. Sand fill shall be compacted where so specified, by 12 tonne vibrating rollers as indicated elsewhere in the Employer's Requirements. The fill material shall be compacted to the specified density, where so specified.

If the density of fill or use of rollers for compaction is not specified, Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by Employer's Representative. However, Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200mm in thickness.

Compaction of sand fill by flooding the area shall be carried out where so specified. In this case, Contractor should ensure that the fill material is not washed away. This work shall be carried out as directed by Employer's Representative.

Soilfill

Approved soil fill consisting of ordinary soil, moorum, soil containing gravel, shingle, etc. shall be deposited in layers not exceeding 200mm. Contractor should ensure that all clods of earth are broken down to a size not larger than 100mm.

Where density of fill or use of rollers is not specified the fill shall be carried out as specified.

Where specified, the required density to fill shall be obtained by proper compaction.

Construction of Peripheral Storm Water Drain

Peripheral Storm water drains shall be constructed at the STP and TSPS site along the boundary to protect the site from the storm water run off. The bottom and side slope of the open channel shall be lined with rubble pitching to minimise erosion and improve carrying capacity.

Quality Control Tests during Construction

The materials used and the works carried out by the Contractor shall conform to the Employer's Requirements prescribed in the preceding clauses.

All quality control tests shall be carried out by the Contractor under the supervision of the authorised representative of Employer's Representative. The results of all completed tests shall be made available to the Employer's Representative. The Contractor shall set up at site, a soil laboratory to carry out all tests and shall provide all equipment, tools, materials and labour for carrying out the same. The testing frequencies specified herein are the minimum but the Employer's Representative shall have the full authority to carry out tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the Employer's Requirements.

- (a) Moisture content Test - One test for every 1000 cubic meters or part thereof of fill.
- (b) Compaction Control Tests - A minimum of one measurement of field density for each 500 sq meters of the compacted area of each layer, or closer as required to yield the minimum number of test results for evaluating a day's work on statistical basis. The determination of field density shall be done in accordance with IS 2720 (Part 28 or 29).

Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one 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 material and the method of compaction is being exercised by the Contractor. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subjected to the condition that the mean dry density equals or exceeds the specified density and the deviation for any set of results is below 0.08gm/cc.

(c) Quality Control Tests at Borrow Pit

At least two boreholes of 6.0 m deep shall be drilled and two trial pits of 2m x 2m x 3m size to be excavated for each 100 m x 100 m area or part thereof. Undisturbed soil samples (90 mm dia and 450 mm long) shall be obtained at every 2.0 m depth interval or at change of soil formation whichever is less in bore hole. Also from each trial pit at least one representative undisturbed samples shall be collected. All samples collected shall be tested in an approved laboratory to confirm the required characteristics specified in the document.

CONCRETE AND ALLIED WORKS

Applicable Codes

Materials

IS:269	Specification for 33 grade ordinary Portland cement. IS:455 Specification for portland slag cement.
IS:1489	Specification for portland-pozzolana cement (Part1&2).
IS:8112	Specification for 43 grade ordinary Portland cement.
IS:12269	Specification for 53 grade ordinary portland cement. IS:12330 Specification for sulphate resisting Portland cement.
IS:383	Specification for coarse and fine aggregates from natural sources for concrete.
IS:432	Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and2)
IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS:1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS:9103	Specification for admixtures for concrete.
IS:2645	Specification for integral cement water-proofing compounds.
IS:4990	Specification for plywood for concrete shuttering work.

Material Testing

IS:4031	Methods of physical tests for hydraulic cement (Parts 1to15)
IS:4032	Method chemical analysis of hydraulic cement.
IS:650	Specification for standard sand for testing of cement.
IS:2430	Methods for sampling of aggregates for concrete.
IS:2386	Methods of test for aggregates for concrete (Parts 1 to8)
IS:3025	Methods of sampling and test (physical and chemical) for water used in industry.
IS:6925	Methods of test for determination of water soluble chlorides in concrete admixtures.

Material Storage

IS:4082	Recommendations on stacking and storing of construction materials at site.
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Concrete Mix Design

IS:10262	Recommended guidelines for concrete mix design.
SP:23(S&T)	Handbook on Concrete Mixes

Concrete Testing

IS:1199	Method of sampling and analysisofconcrete.IS:516 Method of test for strength of concrete.
IS:9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.

IS:8142 Method of test for determining setting time of concrete by penetration resistance.

IS:9284 Method of test for abrasion resistance of concrete. IS:2770 Methods of testing bond in reinforced concrete.

Equipments

IS:1791 Specification for batch type concrete mixers.

IS:2438 Specification for roller pan mixer.

IS:4925 Specification for concrete batching and mixing plant.

IS:5892 Specification for concrete transit mixer and agitator.

IS:7242 Specification for concrete spreaders.

IS:2505 General Requirements for concrete vibrators: Immersion type. IS:2506

General Requirements for screed board concrete vibrators.

IS:2514 Specification for concrete vibrating tables.

IS:3366 Specification for pan vibrators.

IS:4656 Specification for form vibrators for concrete.

IS:11993 Code of practice for use of screed board concrete vibrators.

IS:7251 Specification for concrete finishers.

IS:2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).

IS:2750 Specification for steel scaffoldings.

Codes of Practice

IS:456 Code of practice for plain and reinforced concrete.

IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

IS:3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)

IS:3935 Code of practice for composite construction.

IS:2204 Code of practice for construction of reinforced concrete shell roof.

IS:2210 Criteria for the design of reinforced concrete shell structures and folded plates.

IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.

IS:5525 Recommendation for detailing of reinforcement in reinforced concrete works.

IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.

IS:9417 Specification for welding cold worked bars for reinforced concrete construction.

IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.

IS:3414 Code of practice for design and installation of joints in buildings.

IS:4326 Code of practice for earthquake resistant design and construction of building.

IS:4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)

IS:2571 Code of practice for laying in situ cement concrete flooring.

IS:7861 Code of practice for extreme weather concreting : Part 1 Recommended practice for hot weather concreting.

IS:875 Code of practice for design loads (other than earthquake) for building structures (Parts 1 to 5)

IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement

IS:2974 Code of practice for design and construction of machine

IS:1893 foundations(Parts 1 to4)
Criteria for earthquake resistant design of structures

Construction Safety

IS.3696 Safety code for scaffolds and ladders. (Parts 1&2)
IS:7969 Safety code for handling and storage of building materials.
IS:8989 Safety code for erection of concrete framed structures.

General

The Employer's Representative shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Employer's Representative's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Employer's Requirements shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the Employer's Representative and after establishing their performance suitability based on previous data, experience or tests.

Materials

Cement

Unless otherwise called for by the Employer's Representative, cement shall be Sulphate Resisting Portland cement conforming to IS: 12330.

Where portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Employer's Representative.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Employer's Representative and until the results of such tests are found satisfactory, it shall not be used in any work.

Aggregates (General)

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform

to IS:383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Employer's Representative.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete.

Water

Water used for both mixing and curing shall conform to IS:456. Potable waters are generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

Reinforcement

Steel for reinforcement shall be high yield strength deformed bars having corrosion resistant characteristics. The steel shall be either Tiscon – CRS of grade Fe 415/ Fe 500 or SAIL's HCR – Rebars Gr M of grade Fe 415 / Fe 500 or Vizag Steel's A1 – Rebars of grade Fe 415 / Fe 500 or equivalent having similar compositions and shall have mechanical properties as per IS 1786 . The reinforcement supplied shall have the following Chemical Properties:

Carbon	% max :	0.200
Sulphur	% max :	0.055
Phosphorus	% max :	0.120
S + P	% max :	0.175

Silicon	%max :	0.450
Manganese	%max :	1.200
Corrosion Resistance Elements	%max:	1.500

Testing of Materials:

(i) Manufacturer's Tests

For each batch of materials supplied Manufacturer's Test Certificate shall be submitted for approval. This certificate shall clearly state that the material being supplied is corrosion Resistant Steel and has been tested for corrosion resistance properties.

(ii) Confirmatory Test

3 specimens of each diameter from each batch shall be tested in an approved laboratory for the following:

Salt Spray Test as per ASTM : B117 – 94 for 96 hours.

For the above test Corrosion Resistance Index (CRI) shall be calculated as :

Corrosion rate in mm/year of Mild Steel bar of same diameter in the particular test

$$\text{CRI} = \frac{\text{Corrosion rate in mm/year of Mild Steel bar of same diameter in the particular test}}{\text{Corrosion rate in mm/year of CRS bar in the same test}}$$

(iii) Acceptance Criteria

Based on the results of tests carried out as mentioned above, the Employer's Representative will decide the acceptance of the batch under test for use in RCC structures, and his decision shall be final and binding on the Contractor.

The charges for all the tests shall be borne by the Contractor and are deemed to have been included in the quoted price. It shall be clearly understood by the Contractor that the confirmatory test stipulated above is mandatory and the time required for such testing shall be catered for in the construction period.

Hot rolled plain round mild bars shall conform to IS 432.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust, or any other substance that will destroy or reduce bond.

Admixtures

Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS:9103 and integral water proofing admixtures to IS:2645.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Employer's Representative. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedment's.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

Samples and Tests

All materials used for the works shall be tested before use.

Manufacturer's test certificate shall be furnished for each batch of cement and when directed by the Employer's Representative, samples shall also be tested by the Contractor in a laboratory approved by the Employer's Representative.

Sampling and testing shall be as per IS:2386 under the supervision of the Employer's Representative.

Water to be used shall be tested to comply with requirements of IS:456.

The Contractor shall furnish manufacturer's test certificates and technical literature for any admixture proposed for use. If directed, the admixture shall be tested at an approved laboratory.

Storing of Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS:4082 shall be complied with.

The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture

from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the Employer's Representative. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

Concrete

General

In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS:456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5 and M10 shall be NOMINAL MIX CONCRETE whereas all other grades, M15 and above, shall be DESIGN MIX CONCRETE.

Structure	Grade of Concrete	Max. Aggregate Size
1. All liquid retaining structures	M30	20 mm
2. Other structures		
(a) for foundation raft	M30	40 mm
(b) for walls, columns, floor beams, circular floor slab	M30	20 mm
(c) for columns, beams, slab set.	M30	20 mm
3. For columns, beams, slabs etc in buildings	M30	20 mm
4. Inlet / Outlet chambers, Valve chambers and pipe trenches		
(a) for foundation raft		
(b) walls, columns	M25	40 mm
	M25	20 mm
(c) for slabs, beams, etc.	M20	20 mm
5. Anchor blocks on pipeline, base slab of storm water drains	M20	40 mm

6. Pipeline encasement, grade slab, ramps, footings under walls, SW drain coping etc.	M20	20 mm
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Design Mix Concrete Mix

Design & Testing

For Design Mix Concrete, the mix shall be designed using any of the four methods given in SP:23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS:456. The design mix shall in addition to such that it is cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in water tight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS:456 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of Concrete (for 20mm downgraded aggregates)
M15	260
M20	315
M25	360

The maximum water cement ratio shall be 0.45 for all liquid retaining structures.

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. Where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, higher quantity of cement shall be used.

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete. The Contractor shall then make trial mixes for each class of concrete using the same Contractor's Equipment and the same materials as are proposed for the Permanent Works. The Contractor shall give 24 hours notice of such trials to enable the Employer's Representative to attend. For each trial mix, three separate and consecutive batches of concrete shall be made by the Contractor and the specimens shall be tested at 7 days and 28 days (9 specimens at 7 days and 9 specimens at 28 days). For 7 days test the acceptance criteria shall be 70% of the corresponding target mean strength.

The Contractor shall not commence concreting in the Permanent Works until details of trial mixes and test results for each class of concrete have been submitted to and approved by the Employer's Representative.

Unless otherwise specified, sand conforming between Zone 2 and Zone 3 shall be used. The sand shall be screened on 6 mm size screen before use for all concrete works.

A trial mix design will be approved by the Employer's Representative with respect to strength if the average compressive strength of the nine specimens each at 7 days and 28 days is more than the specified target mean strength appropriate to the grade of concrete.

Percolation test shall be conducted with trial mix in laboratory.

For concrete of Grade M20 and over the Contractor shall cast two sample wall panels 48 hours apart. Each shall be cast in two equal lifts to form a wall panel having one horizontal construction joint formed in the manner proposed by the Contractor for the Works. The top surface of the second lift shall have a Type U3 finish. The panels shall not be touched up after stripping. The panels shall be 300 mm thick and 1.5 m long by 1.5 m high. The Contractor shall not commence concreting in the Permanent Works until the test panels have been approved by Employer's Representative.

The Contractor shall not alter the approved mix proportions nor the approved source of supply of any of the ingredients without having previously obtained the approval of the Employer's Representative.

During production, the Employer's Representative may require trial mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.

It shall be the Contractor's sole responsibility to carry out the mix designs. He shall furnish to the Employer's Representative at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456.

Grade of Concrete	Minimum Compressive Strength N/sq.mm at 7 days	Specified Characteristic Compressive Strength N/sq.mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Employer's Representative is given below :

Structure/Member	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	40
Plain footings, caissons and substructure walls	75	40
Slabs, Beams and reinforced walls	100	40
Pump & miscellaneous Equipment Foundations	75	40
Foundations	100	40
Building columns Pavements	50	40
Heavy mass construction	50	40

Note: All concrete for liquid retaining structures shall have a minimum slump value of 60 mm and maximum of 100 mm.

Batching & Mixing of Concrete

It is expected that batching plants of suitable capacity and pumps for placing concrete shall be used. However, the Contractor shall submit programme of concrete and allied works during the award of contract which will be reviewed accordingly. Proportions of aggregates and cement, as determined by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by the Employer's Representative shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Employer's Representative. Sampling and

testing of strength and workability of concrete shall be as per IS:1199, IS:516 and IS:456.

Nominal Mix

Concrete Mix Design & Testing

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 3 of IS:456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Batching & Mixing of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only.

Formwork

Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, false work, wedges etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Employer's Representative, the drawings and calculations for the design of the formwork shall be submitted to the Employer's Representative for approval.

Formwork shall be designed to fulfill the following requirements:

Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

Made of suitable materials, capable of providing concrete of the correct shape and surface finish within the specified tolerance limits, Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces, Capable of easily striking without shock, disturbance or damage to the concrete.

Soffit forms capable of imparting a camber if required.

Soffit forms and supports capable of being left in position if required.

Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Employer's Representative. Timber for formwork shall be well seasoned, free from sap,

shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Employer's Representative. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete. Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. In the latter case, non-removable through bolts with plastic cones shall be provided and the bolts shall be cut at 25 mm depth from the surface and the conical cavity made good with non-shrink grout just after striking the formwork.

All corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size, unless otherwise stated on the drawings or elsewhere.

Forms for substructure may be omitted when, in the opinion of the Employer's Representative, the open excavation is firm enough (in hard non-porous soils) to act a form. Such excavations shall be larger, as approved by the Employer's Representative, than that required as per drawing to compensate for irregularities in excavation. The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the Employer's Representative. The Contractor shall temporarily and securely fix items to be cast (embedments / inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete.

The striking time for formwork shall be determined based on the following requirements:

- Development of adequate concrete strength;
- Permissible deflection at time of striking formwork;
- Curing procedure employed - its efficiency and effectiveness;
- Subsequent surface treatment to be done;
- Prevention of thermal cracking at re-entrant angles;
- Ambient temperatures; and
- Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Under normal circumstances (generally where temperatures are above 20°C) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by the Employer's Representative. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the Employer's Representative. It is the contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5°C. Local warming may be permitted if steel is kept below 100°C.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules to be prepared by the Contractor. Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Employer's Representative.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the Employer's Representative prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Tolerances

Tolerances for R.C. Buildings

Variation from the Plumb

- (i) In the lines and surfaces of columns, piers, walls and in rises 5 mm per 2.5 m or 25 mm, whichever is less.
- (ii) For exposed corner columns and other conspicuous lines
In any bay or 5 m maximum - 5mm
In 10 m or more - 10mm

Variation from the level or from the grades indicated on the drawings

- (i) In slab soffits, ceilings, beam soffits, and in arises
 - In 2.5m - 5mm
 - In any bay or 5 m maximum - 10mm
 - In 10 m or more - 15mm
- (ii) For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:
 - In any bay or 5 m maximum - 5mm
 - In 10 m or more - 10mm

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

In any bay or 5m maximum - 10mm
In 10 m or more - 20mm

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

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

Minus - 5mm

Plus - 10mm

Footings

- (i) Variation in dimension in plan

Minus - 5mm
Plus - 50mm

- (ii) Misplacement or eccentricity

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

- (iii) Reduction in thickness

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

Variation in steps

- (i) In a flight of stairs

Rise - 3mm

Tread - 5mm

- (ii) In consecutive steps

Rise - 1.5 mm

Tread - 3.0 mm

Tolerances in other structures

All structures

- (i) Variation of the construction linear outline from established position in plan

- | | | |
|-----------------|---|------|
| In 5m | - | 10mm |
| In 10 m or more | - | 15mm |
- (ii) Variations of dimensions to individual structure features from established positions
- | | | |
|------------------------|---|------|
| In 20 m or more | - | 25mm |
| In buried construction | - | 50mm |
- (iii) Variation from plumb, from specified batter or from curved surfaces of all structures
- | | | |
|------------------------|---|-------------------------|
| In 2.5m | - | 10mm |
| In 5m | - | 15mm |
| In 10 m or more | - | 25mm |
| In buried construction | - | Twice the above amounts |
- (iv) Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arises.
- | | | |
|------------------------|---|-------------------------|
| In 2.5m | - | 5mm |
| In 7.5m | - | 5mm |
| m or more | - | 10mm |
| In buried construction | - | Twice the above amounts |
- (v) Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members
- | | | |
|-------|---|------|
| Minus | - | 5mm |
| Plus | - | 10mm |
- (vi) Variation in the thickness of slabs, walls, arch sections and similar members
- | | | |
|-------|---|------|
| Minus | - | 5mm |
| Plus | - | 10mm |

Footing for columns, piers, walls, buttresses and similar members

- (i) Variation of dimension in plan
- | | | |
|-------|---|------|
| Minus | - | 10mm |
| Plus | - | 50mm |
- (ii) Misplacement or eccentricity
- 2% footing width in the direction of misplacement but not more than 50 mm
- (iii) Reduction in thickness
- 5% of specified thickness subject to a maximum of 50 mm.

Tolerance in fixing anchor bolts shall be as follows:

- | | | |
|---|---|------------------------|
| (i) Anchor bolts without sleeves | : | 1.5 mm in plan |
| (ii) Anchor bolts with sleeves | : | 5.0 mm in elevation |
| - for bolts upto and including 28mm dia | : | 5 mm in all directions |

- for bolts 32 mm dia and above : 3 mm in all directions
- (iii) Embedded parts : 5 mm in all directions

Preparation Prior to Concrete Placement

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be approved by the Employer's Representative.

Transporting, Placing and Compacting Concrete

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.

Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following :

- Continuously between construction joints and pre- determined abutments. Without disturbance to forms or reinforcement.
- Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
- Without dropping in a manner that could cause segregation or shock.

In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.

Do not place if the workability is such that full compaction cannot be achieved.

Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.

If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

Ensure that there is no damage or displacement to sheet membranes.

Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators for compaction of concrete shall be electrically operated and vibrator needles shall be of 60 mm size only. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Employer's Representative. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

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 before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Employer's Representative. Concrete shall be protected against damage until final acceptance.

Mass Concrete Works

Sequence of pouring for mass concrete works shall be as approved by the Employer's Representative. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

Curing

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

- Premature drying out, particularly by solar radiation and wind;
- leaching out by rain and flowing water;
- rapid cooling during the first few days after placing;
- high internal thermal gradients;
- low temperature or frost;
- vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless approved otherwise by the Employer's Representative, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is approved to be used by the Employer's Representative, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Employer's Representative before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

Construction Joints and Keys

Construction joints will be as shown on the drawing or as approved by the Employer's Representative. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Employer's Representative.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Employer's Representative.

As soon as the exposed concrete has sufficiently hardened, the surface of the joint shall be water jetted or brushed with a stiff brush to expose the larger aggregate without being disturbed. Alternatively, if the preparation is not satisfactory, or proper joint preparation is not possible due to inclement weather, the Contractor shall thoroughly remove the laitance of hardened concrete by mechanical chipping after seven days of concrete work at his own cost. Before placing fresh concrete against a construction joint all loose material shall be removed and the surface sluiced with water until it is perfectly clean, thereafter all ponded water should be removed.

When concreting is to be resumed on a surface which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

Foundation Bedding

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 or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Employer's Representative. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

Finishes General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

Surface Finish Type F1

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

Surface Finish Type F2

The appearance shall be that of a smooth dense, well- compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

Surface Finish TypeF3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arises, airholes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

Unformed Surfaces

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 ClassU1.

Class U1 finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface. Class U1 finish shall be a levelled and screeded, uniform plain or ridged finish which (unless it is being converted to Class U2, U3, or bonded concrete) shall not be disturbed in any way after the initial set and during the period of curing, surplus concrete being struck off immediately after compaction.

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 a 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 has 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.

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. Where specified, a floor hardener as approved by the Employer's Representative shall be supplied and used as recommended by the manufacturer.

Repair And Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc. shall be inspected by the Employer's Representative who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Employer's Representative.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Employer's Representative as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Employer's Representative.

All the form bolt repairs and delayed repairs shall be carried out using a proportion of white cement in repair mix to the approval of the Employer's Representative so as to match the colour of the surrounding area.

Vacuum Dewatering of Slabs

Where specified, floor slabs, either grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the Employer's Representative's approval.

Hot Weather Requirements

Concreting during hot weather shall be carried out as per IS:7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40°C at the time of placement of fresh concrete.

Where directed by the Employer's Representative, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces.

Liquid Retaining Structures

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be hydro-tested.

The Contractor shall make all arrangements for hydro-testing of structure such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the Employer's Representative. All such rectification shall be done by the Contractor to the entire satisfaction of the Employer/Employer's Representative.

Testing Concrete Structures for Leakage

Water testing of concrete structures shall be done with potable water. Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the Employer's Representative. This test shall be carried out preferably in dry season in accordance with the procedure given below:

The water tightness test shall be carried out when the reservoir is ready for filling. Before the filling operation is started, the tank shall be jointly inspected by the Employer's Representative and the Contractor's Representative and the condition of surfaces of wall, contraction and expansion joints shall be noted and it shall be ensured that jointing material filled in the joints is in position and all openings are closed. The filling of the tank then shall be carried out gradually at the rate not exceeding 30 mm rise in water level per hour and shall preferably extend over a period of 72 hours. Records of leakages starting at different level of water in the reservoir, if any, shall be kept. The reservoir once filled shall be allowed to remain filled for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded again at subsequent interval of 24 hours over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level of a period of seven days shall be taken as indication of the water tightness of the tank, which for all practical purpose, shall not exceed 40 mm. If the structure does not satisfy the conditions of the test and a daily drop in water level is found, the period of test may be extended for a further period of seven days and if the specified limit is then reached the structure may be considered as satisfactory. The Employer's Representative shall decide on the actual permissible nature of the drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses.

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

Each compartment/segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

Optional Tests

If the Employer's Representative feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Employer's Requirements or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Employer's Representative, as per relevant IS Codes.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the Employer's Representative reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The Employer's Representative also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer.

Grouting Standard Grout

The proportion of Standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted, shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting, water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by the Employer's Representative. The grout proportions shall be limited as follows:

Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25mm	One part Portland Cement to one part sand	0.44
b) General mix	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53

Non-Shrink Grout

Non –shrink grout where required as instructed by the Employer's Representative, shall be provided in strict accordance with the manufacturer's instructions / specifications on the drawings.

Inspection

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Employer's Representative. Materials rejected by Employer's Representative shall be expressly removed from site and shall be replaced by Contractor immediately.

Clean-Up

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

Acceptance Criteria

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

- a) properties of constituent materials;
- b) characteristic compressive strength;
- c) specified mix proportions;
- d) minimum cement content;
- e) maximum free-water/cement ratio;
- f) workability;
- g) temperature of fresh concrete;
- h) density of fully compacted concrete;
- i) cover to embedded steel;
- j) curing;
- k) tolerances in dimensions;
- l) tolerances in levels;
- m) durability;
- n) surface finishes;
- o) special requirements such as;
 - i) watertight ness
 - ii) resistance to aggressive chemicals
 - iii) resistance to freezing and thawing
 - iv) very high strength
 - v) improved fire resistance
 - vi) wear resistance

vii) resistance to early thermal cracking

The Employer's Representative's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor.

For work not accepted, the Employer's Representative may review and decide whether remedial measures are feasible so as to render the work acceptable. The Employer's Representative shall in that case direct the Contractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor by the Employer for executing the remedial measures.

Water stops Material

The material for the PVC water stops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS:8543.

a)	Tensile strength	:	11.6 N/mm ² minimum
b)	Ultimate elongation	:	300%minimum
c)	Tear resistance	:	4.9 N/mm ² minimum
d)	Stiffness in flexure	:	2.46 N/mm ² minimum
e)	Accelerated extraction		
i)	Tensile strength	:	10.50 N/mm ² minimum
ii)	Ultimate elongation	:	250%minimum
(f)	Effect of Alkali	:	7days
i)	Weight increase	:	0.10%maximum
ii)	Weight decrease	:	0.10%maximum
iii)	Hardness change	:	± 5points

(g)	Effect of Alkali	:	28days
i)	Weight increase	:	0.40%maximum
ii)	Weight decrease	:	0.30%maximum
iii)	Dimension change	:	±1%

PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use. For floors only surface type water bars (PVC) shall be used.

PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Employer's Representative before procurement for incorporation in the works.

Workmanship

Water stops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Water stops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of water stops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Water stops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the water stops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting water stop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

Preformed Fillers and Joint Sealing Compound Materials

Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS:1838 (Part I).

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS:702. Bitumen primer shall conform to IS:3384.

Sealants shall be of the following types :

Sealant Type A

Sealant Type A shall be a gun grade, non-slumping compound suitable for sealing horizontal, vertical and soffit joints in water retaining structures. It shall be a UK WFBS material approved for unrestricted use in contact with potable water to the full exposure condition of 15000 mm²/l, and shall not support bacterial growth.

It shall be stable and shall have a low water absorption and good adhesion to concrete.

Hardness (ShoreA) >12
Transverse Movement Accommodation : ±15%

Sealant Type B

Sealant type shall be a gun grade compound, suitable for sealing vertical movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.

Hardness (ShoreA) >12
Transverse Movement Accommodation : ±12.5%

Sealant Type C

Sealant type C shall be similar to Type B above. In addition it shall have been designed for sealing movement and construction joints in hydraulic and water retaining structures and shall be suitable for use in contact with potable water.

Hardness(ShoreA) : >20
Transverse Movement Accommodation : ±12.5%

Sealant Type D

Sealant Type D shall be a pourable compound suitable for sealing horizontal movement and construction joints in concrete structures. It shall be flexible, resistant to aging, physical damage and weathering and shall have good adhesion to concrete.

Hardness (ShoreA) : >9
Transverse Movement Accommodation : ±12.5%

Sealant Type E

Sealant Type E shall be a cold pouring compound complying with BS 5212, suitable for sealing movement and construction joints in concrete paved areas. It shall be resistant to fuels, oils and hydraulic fluids. It shall be tough, abrasion-resistant and shall not decompose in strong sunlight.

Hardness (ShoreA) : >12
Transverse Movement Accommodation : ±12.5%

The hardness value specified in the above summaries is the Shore A Durometer value at 14 days at 25° C and 50% RH. The specified transverse movement values are based on joints having a width to depth ratio of 1.5 : 1.

The Contractor may use the above sealants or ones meeting equivalent or higher specifications.

Workmanship

The thickness of the preformed bitumen impregnated filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipments. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS:3384 in order to improve the adhesive quality of the sealing compound.

Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Employer's Representative.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it.

Joint sealing shall not be commenced without the approval of the Employer's Representative. In reservoir joints the sealer shall be poured after completion of the water tightness test, to the satisfaction of the Employer's Representative.

All joint sealers shall be from an approved manufacturer. The Contractor shall supply the manufacturer's test certificates for each consignment of each type of joint sealant delivered to the Site and shall if requested supply to the Employer's Representative sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

Sealants shall be installed in strict accordance with the manufacturer's instructions. De-bonding strip shall be used in conjunction with the sealers as indicated on the Drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to

attach from the primer used to bond the sealer to the concrete.

Polysulphide and polyurethane sealants shall not abut bitumen sealers. Surfaces to receive Polysulphide and polyurethane sealants shall be kept free from bituminous paints. All sealants shall be appropriate for the prevailing climatic conditions. Bituminous sealants shall comply with the BS 2499 for Type A1. Polysulphide sealants shall comply with IS12118.

Concreting Records

A written record of the concrete works shall be made each day by the Contractor and kept available for inspection by the Employer's Representative. The diary shall contain notes and records of :

- (a) The names of the Contractor's Engineer who are responsible for the different phases of the concrete work and also the names of their assistants.
- (b) The temperatures of air, water, cement, aggregates, together with the air humidity and type of weather.
- (c) Deliveries to the Site of concrete materials (quantity, brand of concrete, etc).
- (d) Inspections carried out, tests performed, etc. and their results.
- (e) Times of commencement and completion of different parts of the concrete works and times of erection and striking of forms.

END OF PART

PART - GENERAL BUILDING WORKS

Applicable Codes and Specifications

The following codes and standards are included in this section.

IS:110	Ready mixed paint, brushing, grey filler, for enamels for use overprimers
IS:269	Specification for 33 grade ordinary Portland cement
IS:280	Specification for mild steel wire for general engineering purposes
IS:287	Recommendations for maximum permissible moisture content of timber used for different purposes
IS : 304	High Tensile Brass Ingots and Castings.
IS:337	Varnish, finishing interior
IS:348	French polish
IS:383	Specification for coarse and fine aggregates from natural sources for concrete
IS:412	Expanded metal steel sheets for general purposes
IS:419	Specification for putty for use on window frames
IS:428	Distemper, oil emulsion, colour as required
IS:459	Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets
IS:702	Specification for industrial bitumen
IS:710	Specification for marine plywood
IS:712	Specification for building limes
IS:730	Specification for hook bolts for corrugated sheet roofing
IS:733	Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes
IS:777	Specification for glazed earthen ware tiles
IS:1003	Specification for timber panelled and glazed shutters (Parts 1&2)
IS:1038	Specification for steel doors, windows and ventilators
IS:1077	Specification for common burnt clay building bricks
IS:1081	Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators
IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS:1237	Specification for cement concrete flooring tiles
IS:1322	Bitumen felts for water proofing and damp proofing
IS:1346	Code of practice for water proofing of roofs with bitumen felts
IS:1361	Specification for steel windows for industrial buildings
IS:1397	Specification for kraft paper
IS:1398	Specification for packing paper, waterproof, bitumen laminated
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS:1477	Code of practice for painting of ferrous metals in buildings(Parts 1 & 2)
IS:1542	Specification for sand for plaster
IS:1580	Specification for bituminous compounds for water-proofing and caulking purposes
IS:1597	Code of practice for construction of stone masonry : Part1Rubble stonemasonry

IS:1659	Specification for block boards
IS:1661	Code of practice for application of cement and cement-lime plaster finishes
IS:1834	Specification for hot applied sealing compound for joint in concrete
IS:1838	Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part 1 Bitumen impregnated fibre
IS:1948	Specification for aluminium doors, windows and ventilators
IS:1949	Specification for aluminium windows for industrial buildings
IS:2074	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2098	Asbestos cement building boards
IS:2114	Code of practice for laying in-situ terrazzo floor finish
IS:2116	Specification for sand for masonry mortars
IS:2185	Specification for concrete masonry units (Parts 1,2 &3)
IS:2202	Specification for wooden flush door shutters (Solid core type): Parts 1 &2
IS:2212	Code of practice for brickwork
IS:2250	Code of practice for preparation and use of masonry mortars
IS:2338	Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
IS:2339	Aluminium paint for general purposes, in dual container
IS:2394	Code of practice for application of lime plaster finish
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 &2)
IS:2402	Code of practice for external rendered finishes
IS:2571	Code of practice for laying in-situ cement concrete flooring
IS:2572	Code of practice for construction of hollow concrete block masonry
IS:2645	Specification of integral cement water proofing compounds
IS:2690	Specification for burnt clay flat terracing tiles : Part1 Machine made
IS:2691	Specification for burnt clay facing bricks
IS:2750	Specification for steel scaffoldings
IS:2835	Flat transparent sheet glass
IS:2932	Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
IS:3007	Code of practice for laying of asbestos cement sheets-corrugated and (Part 1 & 2) semi-corrugated sheets
IS:3036	Code of practice for laying lime concrete for a water-proofed roof finish
IS:3067	Code of practice of general design details and preparatory work for damp-proofing and water- proofing of buildings
IS:3068	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
IS:3384	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3461	Specification for PVC-asbestosfloortiles
IS:3462	Specification for unbacked flexible PVC flooring
IS:3495	Method of test for burnt clay building bricks: Part 1 to4

IS:3536	Specification for ready mixed paint, brushing, wood primer, pink
IS:3564	Specification for door closers (hydraulically regulated)
IS:3696	Safety code of scaffolds and ladders (Parts 1&2)
IS:3935	Code of practice for composite construction
IS:4020	Methods of test for wooden flush door : Type test
IS:4021	Specification for timber door, window and ventilator frames
IS:4351	Specification for steel doorframes
IS:4443	Code of practice for use of resin type chemical resistant mortars
IS:4457	Specification for ceramic unglazed vitreous acid resisting tile
IS:4631	Code of practice for laying epoxy resin floor toppings
IS:4832	Specification for chemical resistant mortars (Part II)
IS:4860	Specification for acid resistant bricks
IS:4948	Specification for welded steel wire fabric for general use
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring
IS:5410	Cement paint, colour as required
IS:5411	Specification for plastic emulsion paint (Parts 1&2)
IS:5437	Wired and figured glass
IS:5491	Code of practice for laying of in-situ granolithic concrete floor topping
IS:6041	Code of practice construction of autoclaved cellular concrete block masonry
IS:6042	Code of practice for construction of light weight concrete block masonry
IS:6248	Specification for metal rolling shutters and rolling grilles
IS:7193	Specification for glass fibre base coal tar pitch and bitumen felts
IS:7452	Specification for hot rolled steel sections for doors, windows and Ventilators
IS:8042	Specification for white Portland cement
IS:8543	Methods of testing plastics
IS:8869	Specification for washers for corrugated sheet roofing
IS:9197	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS:10005	SI units and recommendations for the use of their multiples and of certain other units.
IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams
BS : 476 (Part – 20)	- Methods for determination of the fire resistance of elements of construction (General Principles)
BS : 476 (Part – 21)	- Methods for determination of the fire resistance of load bearing elements of construction
BS : 476 (Part – 22)	- Methods for determination of the fire resistance of non-load bearing elements of construction

Brickwork

Materials

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work prepared by the Contractor.

The nominal size of the modular brick shall be 200mmx100mmx100mm with the permissible tolerances over the actual size of 190mmx90mmx90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance upto ± 3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the Items of work prepared by the Contractor.

The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the Employer's Representative for approval and bricks supplied shall conform to approved samples. If demanded by Employer's Representative, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by Employer's Representative shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work prepared by the Contractor. Sand for masonry mortar shall conform to IS:2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Employer's Representative. If so directed by the Employer's Representative, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Employer's Representative. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The Contractor shall arrange for test on mortar samples if so directed by the Employer's Representative.

Workmanship

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work prepared by the Contractor. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilized only to make up required wall length or for bonding. Bricks shall be laid with frog upper most.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain. Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Employer's Representative.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Employer's Representative. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.

In the event of usage of traditional bricks of size 230 mm x115mm x75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either sides of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transomes and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.

Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand mortar 1:4 over all the steel

surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

Facing bricks of the type specified conforming to IS:2691 shall be laid in the positions indicated on the Drawings prepared by the Contractor and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works prepared by the Contractor. The pattern of laying the bricks shall be as specifically indicated in the Drawings prepared by the Contractor.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times.

Uncoursed Random Rubble Masonry, in Foundation, Plinth and Superstructure Materials

Stones for the works shall be of the specified varieties which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS:1124. The Contractor shall supply sample stones to the Employer's Representative for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6. Materials and preparation of mortar shall be as specified in Clause 18.2.1.

Workmanship

For all Works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls upto 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45deg. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in this section.

Coursed Rubble Masonry (First Sort) for Superstructure Materials

The Material specification for the work shall be as per specifications.

Workmanship

All Courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and atleast 1/3rd the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by atleast 75 mm.

The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for atleast 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinnings shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 18.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane. Type of scaffolding to be used shall be as per specification.

Requirements of execution of the work and curing shall be as stipulated in these specifications.

Concrete Block Masonry Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of

IS : 2185 (Part I). Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

Length 400, 500 or 600 mm

Height 100 or 200 mm

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than ± 5 mm and maximum variation in height or width of the units shall not be more than ± 3 mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.

Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of Employer's Representative.

Workmanship

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS:2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 18.2.1.

The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, leveled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis.

For jambs of doors, windows and openings, concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of

doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall be laid up at the same time with a true masonry bond between atleast 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 18.2 for the brickwork.

Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet. Double scaffolding shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

Damp - Proof Course Materials and Workmanship

Where specified, all the walls in a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm downgraded coarse aggregates.

The surface of brick work/stone masonry work shall be leveled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster. Damp-proof course shall be cured properly for atleast seven days after which it shall be allowed to dry for taking up further work.

Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedments etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction Drawings to be prepared by the Contractor prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the Employer's Representative. In the event, of any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the Employer's Representative.

Woodwork in Doors, Windows, Ventilators & Partitions Materials

Timber to be used shall be first class Teak wood as per IS: 4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for

timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

Flush door shutters of the solid core type with plywood face panels shall conform to IS:2202 (Part 1) and with particle board/hard board face panels shall conform to IS:2202 (Part 2).

Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.

Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

Workmanship

The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

All works shall be executed as per the detailed Drawings prepared by the Contractor and/or as directed by the Employer's Representative.

All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortise and tendon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work prepared by the Contractor. The workmanship shall generally conform to the requirements specified in IS:4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.

Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and window frames, one at the centre and the other two at 300 mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the Drawings prepared by the Contractor. The stiles and rails shall be joined by mortise and tendon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS:1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS:710 shall be used for doors where specified.

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louver opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS:710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS:4020, if so desired by the Employer's Representative.

Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS:2835. The thickness and type of glazing to be provided shall be as specified.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminum shall be as specified. The number, size and type of the fittings and fixtures shall be as specified.

Wood work shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the Employer's Representative. The type of finish and the number of coats shall be as stipulated in the respective items of work prepared by the Contractor.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the drawings prepared by the Contractor.

The framework of the partitions with mullions and transomes shall be with the sections of dimensions as specified. Panels of double/single glazing/plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings prepared by the Contractor.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Employer's requirements.

Steel Doors, Windows and Ventilators Materials

Hot rolled steel sections for the fabrication of steel doors, windows and ventilators shall conform to IS : 7452 which are suitable for single glazing .

Pressed steel door frames for steel flush doors shall be out of 1.25mm thick mild steel sheets of profiles as per IS : 4351.

Transparent sheet glass shall conform to the requirements of IS : 2835. Wired and figured glass shall be as per IS : 5437.

Builder's hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

Workmanship

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work prepared by the Contractor and of sizes as indicated in the drawings prepared by the Contractor. Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS : 1038. Steel windows shall conform to IS : 1361, if so specified.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and mitred. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS: 1038. Tolerance in overall dimensions shall be within ± 1.5 mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the Employer's Representative before further manufacture/purchase by the Contractor.

Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and / or as shown in the drawings prepared by the Contractor for single or composite units.

For windows with fly proof mesh as per the item of work prepared by the Contractor, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.

Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS : 4351. Pressed steel door frames shall be fixed as 'built-in' as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the door frame, without leaving any voids.

Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame.

Door shutters of flush welded construction shall be 45mm thick, fabricated with two outer skins of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge bevelled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/or drawings prepared by the Contractor. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the drawings prepared by the Contractor.

Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The dimensions of the masonry opening shall have 10mm clearance around the overall

dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thickness as specified in the items of works prepared by the Contractor. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in Drawings prepared by the Contractor.

Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanized with thickness of the zinc coating as stipulated all as described in the respective items of works prepared by the Contractor.

The material of the Builders' hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the items of works prepared by the Contractor. The number, size and type of fittings and fixtures shall be as in the Drawings /items of works prepared by the Contractor.

Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc required for fixing shall be made by the Contractor and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

Aluminum Doors, Windows, Ventilators & Partitions Materials

Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.

Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.

Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

Workmanship

All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminum windows, shall conform to IS:1949, if so specified.

All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within ± 1.5 mm. The frames and shutters shall be free from

warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminium swing type doors, aluminum sliding windows, partitions shall be as specified.

IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running metre of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are being continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor, will be reviewed by the Employer's Representative and will be accepted only if they are equal to or marginally more than that given in the codes/as specified.

The framework of the partitions with mullions and transoms shall be with anodized aluminium box sections. Anodized aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the drawings to be prepared by the Contractor. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction drawings to be prepared by the Contractor.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 18.9.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works prepared by the Contractor. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

Steel Rolling Shutters Materials and Workmanship

Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS:6248.

The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the drawings prepared by the Contractor.

Shutters shall be built up of interlocking laths 75 mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS:6248 for various clear widths of the shutters.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.

Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of works prepared by the Contractor.

In case of galvanised rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be atleast 610gms/sq.m.

Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

Stone Pitching

Stone pitching to slopes shall be carried out where indicated or as directed by the Employer. Stone for pitching shall be obtained from an approved source and shall be hard, sound, durable, clean and generally as specified elsewhere in the specification. The minimum dimension of any stone shall be atleast equal to the specified thickness of the pitching.

After excavation / filling and trimming, slopes to be pitched shall be spread with a 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 wedged into the cracks. Joints in stone pitching shall be flushed up with sand/cement mortar or as directed by Employer on completion.

Rubble Sub-Base Materials

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Employer's Representative.

Workmanship

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely. The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in items of works prepared by the contractor.

Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

Terrazzo and Plain Cement Tiling Work Materials

Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS:1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14N/mm^2 .

The type, quality, size, thickness colour etc, of the tiles for flooring/dado/skirting shall be as specified.

The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm upto 6mm or from 1mm upto 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.

Workmanship

Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS:1443. Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.

About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the Contractor shall procure sufficient quantity of extra tiles to meet this contingency.

Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped

against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish.

Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

Machine grinding and polishing shall be commenced only after a lapse of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS: 1443.

Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localized deviation of ± 3 mm in any 3m length is acceptable in a nominally flat floor.

In-Situ Terrazzo Work Materials

The requirements of marble aggregates for terrazzo topping shall be as per specifications and/or relevant IS Code. Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

Workmanship

The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado/ skirting shall be as specified in the respective items of works prepared by the Contractor. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The under layer shall be of cement concrete of mix 1:2:4 using 10mm downgraded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/ skirtingwork.

The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

Both the under layer and later the topping shall be divided into panels not exceeding 2 sq.m for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of atleast 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works prepared by the Contractor. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the under layer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the underlayer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry, the underlayer shall be spread and levelled with a screeding board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the under layer is still plastic and normally between 18 to 24 hours after the under layer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of troweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS:2114.

Shahabad / Tandur/ Kota Stone Slab work Materials

The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be ± 5 mm. This shall be ± 2 mm on

dimensions less than 100mm.

Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

Workmanship

The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/skirting shall be as specified in the respective items of works prepared by the Contractor. Preparation of the concrete base, laying and curing shall be as relevant IS code and/or specifications.

Dado / skirting work shall be as per relevant IS Code and/or specifications.. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

Grinding and polishing shall be as per specifications and/or IS code except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

Carborundum Tile Finish Materials

Carborundum tiles shall generally conform in all respects to the standards stipulated in IS:1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm².

The topping shall be uniform and of thickness not less than 6mm. The quantity of carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.

Workmanship

Requirements as detailed for terrazzo/cement tile finish under clause 18.14.2 shall be applicable for carborundum tile flooring.

Glazed Tile Finish Materials

Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

Workmanship

The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.

Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

Neat cement slurry using 3.3 kg cement per sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

All the joints shall be cleaned of grey cement with wire brush to a depth of atleast 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

In-Situ Cement Concrete Floor Topping Materials

The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one part cement : two and half parts sand : three and half parts coarse aggregates) by volume unless otherwise specified.

The aggregates shall conform for the requirements of IS:383.

Coarse aggregates shall have high hardness surface texture and shall consist of

crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS:2571. Grading of the sand shall be within the limits indicated in IS:2571.

Workmanship

The thickness of the floor topping shall be as specified in the items of work prepared by the Contractor. The minimum thickness of the floor topping shall be 25mm.

Preparation of base concrete/structural slab before laying the topping shall be as per relevant specifications and or IS code. The surface shall be rough to provide adequate bond for the topping.

Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Employer's Representative. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of at least one day. Construction joints shall be plain vertical butt joints.

Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.

Finishing of the surface by troweling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be re-trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerances is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finishes which are difficult to repair satisfactorily.

In-Situ Granolithic Concrete Floor Topping Materials and Workmanship

The Requirements of materials and workmanship shall be all as per IS code and/or specification for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement: sand: coarse aggregates) by volume. The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

Floor Hardener Topping Materials & Workmanship

Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish on top of hardened concrete base.

Floor hardener of the metallic or non-metallic type suitable for the performance of normal / medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work prepared by the Contractor.

For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per relevant specification. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.

The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

PVC Sheet/Tile Flooring

Materials

PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS:3462 or homogeneous PVC asbestos tiles conforming to IS:3461.

The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the Employer's Representative.

Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark, and batch number.

The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work prepared by the Contractor .

Workmanship

PVC Floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the under bed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS: 5318.

The surface of the under bed shall have trowelled finish without any irregularities which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the under bed until the A/C units have been in operation for atleast 7 days. During this period, the temperature range shall be between 20deg.C and 30deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

Layout of the PVC flooring shall be marked with guidelines on the under bed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout. The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slid on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

Acid Resisting Brick/Tiling Work Materials

The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS:4457. Acid resistant bricks shall conform to the requirements of IS: 4860.

The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS: 4832 (Part II). Method of usage shall generally be as per the requirements of IS: 4443.

Workmanship

The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS: 3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS: 1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

Resin mortars are normally self curing. The area tiled shall not be put to use before 48

hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

Heavy Duty Abrasion Resistant 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 this selection. Tiles shall be hardwearing, resistant to impact, resistant to abrasion, free from slipperiness and also resistant to attack by water, oils and greases.

Epoxy Lining Work Materials

The epoxy resin and hardener formulation for laying of jointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS:9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure :

- a) Hydrochloric acid upto 30%concentration
- b) Sodium hydroxide upto 50%concentration
- c) Liquid temperature upto60deg.C
- d) Ultra violet radiation
- e) Alternate wetting and drying

Sand shall conform to grading zone III or IV of IS:383.

The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the Employer's Representative.

Workmanship

The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 das of laying of the lining.

Water-Proofing General

The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Employer's Representative.

The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick bat coba shall be covered as specified below.

The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the Employer's Representative.

Modified Bituminous Membrane Water Proofing

Modified Bituminous Membrane shall be a proprietary product from an approved experienced manufacturer comprising bitumen and a core reinforcement material with protective film layers. "SUPER THERMOLAY" 4 mm thick weighing 4 Kg/sqm, manufactured using APP Polymer modified bitumen with a central core of non-woven polyester reinforcement (200 gms/sqm) and with top and bottom layers of thermofusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited and "PLYFLEX" of Bitumat Company Limited, Saudi Arabia supplied by STP Limited are examples of acceptable materials. Other materials of equivalent specification may be provided, all subject to the approval of the Employer's Representative.

The work shall include waterproofing for the reservoir roof slabs and any other areas as directed by the Employer's Representative. The waterproofing treatment shall be applied as follows :

- (a) The top surface of slab shall be cleaned off dirt by air blower
- (b) A layer of cold applied bituminous primer at 0.20 kg/sqm shall be applied
- (c) A coat of blown bitumen 85/125 shall be applied at the rate of 1.45kg/sqm
- (d) A roll of modified bituminous membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done where recommended by the manufacturer and where directed by the Employer's Representative as the unrolling progresses.

The side overlaps shall be 100 mm whereas end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching. Care shall be taken that membrane is lapped with treatment along the vertical surface and roof gutter treatment for at least 500 mm. The membrane shall be properly overlapped /

terminated at all openings, rainwater down takes etc., to ensure that such junctions do not become source of leakage.

- (e) A layer of 40 mm thick M15 grade screed with 10 mm downgraded aggregate shall be provided over membrane and finished smooth with wooden float.

This work shall be carried out by an experienced specialist Contractor who shall be appointed only after prior approval of the Employer's Representative.

Waterproofing of Roofs with Lime Concrete Materials

Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS: 3068. Lime shall be class C lime (fat lime) or factory made hydrated lime conforming to IS: 712.

Workmanship

Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12kg of washing soap and 4kg of alum. Brick aggregates shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing. The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS: 3067.

The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer.

The average thickness of lime concrete, slope and the finish on top of machine made burnt clay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work to be prepared by the Contractor. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work prepared by the Contractor, duly considering the traffic the terrace will be subjected to.

The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it shall be laid in layers not exceeding 100mm to 125mm.

Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the down take points.

Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.

After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done

using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections.

During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothed with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the Employer's Representative.

- a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.
- b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously.

Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days.

Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carried out in similar fashion as described for clay tiles in above paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

Waterproofing of Roofs/Terraces etc.

Water proofing of Horizontal Surfaces

The waterproofing shall be applied as follows:

A coat of Blown Bitumen 85/25 shall be applied at the rate of 1.45 kg/sq.km

A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done, where recommended by the manufacturer and where directed by the Engineer-in-Charge, as the unrolling progresses. The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching. Care shall be taken that the membrane is lapped with the treatment along the vertical surface and roof gutter treatment for at least 500 mm. The membrane shall be properly overlapped/terminated at all openings, rainwater down takes etc. to ensure that such junctions do not become sources of leakage. Top of membrane finally shall be painted with antiglouse reflective paint.

Waterproofing of Vertical Surfaces at Roof Level and Gutters

The Water proofing shall be applied as described in (a) above.

Modified Bituminous membrane shall be unrolled and bonded to the substrate after applying a coat of bitumen and by pressing down evenly for the full width of the roll. Light torching shall be done to ensure complete bonding. The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm. The membrane shall be taken up to a pre-cut chase anchored and sealed.

Khurras and Rainwater Down Pipes

Down pipes shall be isolated from RCC work with 6 mm polyethylene foam fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane. A water proofing flashing composed of one layer of Hessian based self finished felt Type 3 Grade 1 and two layers of aluminium foil of 0.075 mm thickness shall be provided. This flashing shall be carried into the down take pipes for at least 150 mm and sealed with hot bitumen. The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down take pipes.

Testing

The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond anywhere on the surface.

Cement Plastering Work Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to

four parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS:1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Employer's Representative. If so desired by the Employer's Representative sand shall be screened and washed to meet the Employer's requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

Workmanship

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS:1661 and IS:2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Employer's Representative.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one

operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the Employer's Representative duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Employer's Representative.

Where specified in the drawings to be prepared by the Contractor, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings to be prepared by the Contractor.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturers instruction while preparing the cement mortar.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used as specified elsewhere in this specification.

The finished plaster surface shall not show any deviation more than 4mm when checked

with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

- a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.
- b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/ thermal movement.
- c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the back ground exists.

Cement Pointing Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Employer's Representative and if so directed it shall be washed/screened to meet specification requirements.

Workmanship

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Employer's Representative.

Metal Lath and Wire Fabric Materials

Welded steel wire fabric shall conform to IS : 4948.
Expanded metal shall conform to IS : 412.
Galvanised wire mesh shall be of approved quality.

Workmanship

The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified in the respective items of work.

For metal lath plastering work, the weight of steel material shall be not less than 1.6 kg/sq.m.

Steel material for use at the junction of brick masonry/concrete shall have the mesh dimensions not greater than 50 mm.

Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter not less than 1.25 mm at spacing not more than 100 mm for lath plastering work. Nailing to wall shall be at spacing not exceeding 200 mm. The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.

Water-Proofing Admixtures

Water-proofing admixture shall conform to the requirements of IS:2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Employer's Representative.

Painting of Concrete, Masonry & Plastered Surfaces Materials

Oil bound distemper shall conform to IS:428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS:5410. The primer shall be a thinned coat of cement paint.

Lead free acid, alkali and chlorine resisting paint shall conform to IS:9862.

White wash shall be made from good quality fat lime conforming to IS: 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Employer's Representative.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Employer's Representative for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

Workmanship

Contractor shall obtain the approval of the Employer's Representative regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata.

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS:2395.

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

White Wash

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

Colour Wash

Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

Cement Paint

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner

shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same colour shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for at least 2 days after the application of final coat. The operations for brushing each coat shall be as detailed above.

Oil bound Distemper

The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for at least 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. At least 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

Acid, Alkali Resisting Paint

A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

Plastic Emulsion Paint

The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

Acrylic Emulsion Paint

Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified.

Flashing

Materials

Anodised Aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm. Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS:1322 or glass fibre base self finished felt Type-2 Grade 1 conforming to IS:7193.

Workmanship

The type of the flashing and method of fixing shall be as specified.

Flashing shall be of the correct shape and size as indicated in the construction drawings to be prepared by the Contractor and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.

Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting as indicated in the drawings to be prepared by the Contractor. Curing of the mortar shall be carried out for a minimum period of 4days.

Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

Thermal Insulation For Ceiling

Thermal insulation shall be "Thermocole" TF type or similar approved or Resin bonded fibre glass boards.

Fixing "Thermocole" Boards

Soffit of R.C.Slab 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/m².

Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen. The boards shall be further secured with screws, washers and plugs.

The joints of the boards shall be sealed with bitumen.

Fiber Glass Boards

Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centers with 6mm x 65mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.

'Crown' 200 fiberglass boards 50mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

The insulation boards shall be covered with 20mm – 24 gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wiremesh with 50mm overlap and secured to the timber pegs by screws.

If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

Plaster of Paris Board False Ceiling Materials

Plaster of Paris Boards

The plaster of paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by Employer's Representative.

The plaster of paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphur trioxide and other requirements as per IS:2547 (Part I) However, its fineness shall be such that the residue, after drying, and sieving on I.S. sieve designation 3.35mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 kg per sq.cm.

The plaster of paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by Employer's Representative. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easy removal of the board. Plaster of paris shall be evenly spread into the form upto about half the depth and hessian cloth or coir shall be pressed over the plaster of paris layer. The weight of hessian cloth or coir in the board shall be 250 gm per sq.m. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. The hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of paris which shall be uniform pressed and then wire cut to an even and smooth surface.

The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.

The size of boards shall generally be 600mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and shall not be exposed to moisture. The boards shall always be carried on edges.

Timber Frame Work

Timber for frame work of false ceiling grid and hangers shall be of good quality and well seasoned. It shall have uniform colour, reasonably straight and close grains and shall be free from knots, cracks and sapwood. It shall be treated with approved anti-termite preservative as directed by the Employer's Representative. Extreme care shall be taken so that the preservative treatment does not stain the ceiling boards. In case metal hangers are used, these shall be M.S. flats or bars, having two coats of red oxide zinc chromate paint primer, as shown on drawings or as approved by Employer's Representative.

Metal Frame Work

The metal frame work may be made of sections of light metal, such as anodised aluminium, mild steel or as shown on the drawings. The shape of cross-section shall be such as to facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

Construction

Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the drawings. Contractor shall also submit a detailed drawing to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.

Structural design of timber member for the frame shall be in accordance with IS : 883, and metal sections shall be of appropriate size and thickness and shall be of approved manufacture, all as approved by Employer's Representative.

The false ceiling grid work shall be carried out as per the approved drawings or as directed by Employer's Representative. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm centre to centre perpendicular to the main runners.

The timber grid work shall be suspended with the help of wooden hangers or metal hangers at 1.2m centre to centre in both the directions. Wooden hangers shall be adopted for flat R.C. roof slab structures whereas metal hangers for flat R.C. roof or structural steel floors / tresses. Metal hangers shall be fabricated from mild steel / galvanised flats of 35mm x 6mm size or bars of 10mm dia. Threaded at the lower end

and anchored securely in the roof concrete or welded to inserts provided on the underside of slabs, beams etc. All M.S. hangers shall be given two coats of red oxide zinc chromate paint primer. In case the roof work is of A.C. sheeting supported on purlins and trusses, hangers shall be suspended from roof steel work. The arrangement of metal hangers shall be such that the level of false ceiling can be adjusted during fixing of the ceiling frame work. The ceiling frame work shall be secured to hangers by means of washers and nuts. The ends of main runners shall preferably be embedded into the masonry work.

The metal frame work when it is anodised aluminium false ceiling grid system shall consist of aluminium main member of special T-Profile of 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodised aluminium wallangles.

In the case of timber frame work, all the edges of the plaster of paris board shall be fixed to frame members by means of counter sunk and rustless screws of 2.74 mm size, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. The joints shall always be in perfect line and plane.

In case of aluminium grid system, boards shall be just placed into the frames formed by the main 'T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint. The boards shall be cut with a saw, if required, to any shape and size.

As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously. Contractor shall provide necessary openings in the false ceiling work for air-conditioning, lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by Employer's Representative.

Finishing

It is essential that false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of Employer's Representative.

The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for aluminium frame work shall be of interlocking type so that when the cross member is in place, it cannot be lifted out.

The countersunk heads of screws and all joints shall be filled with plaster of paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be

necessary to enable the trowelling of the scrim down to the board.

Fire Stopping

In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by Employer's Representative (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system, 'for guidance).

False or Cavity Floor Frame Work

The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia. anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities upto plus or minus 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

Floor Panels

The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cu.m bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS:3087-specification for wood particle boards (Medium Density)for general purposes.

The thermal conductivity of the boards shall not exceed 0.12 kCal/hr/sq.m/deg./C/m.

The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with panel size not more than 600mm under any circumstances. Exposed 2mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire resistant paint from underside.

The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 – "Specification for unbacked flexible PVC flooring" and of approved colour and shade. The completed panel shall be completely removable

and shall remain in position without screwing or bolting to the on the inner side with stickers for easy identification and reassembly whenever required.

Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading.

Suitable removable covers shall be provided to serve as outlets for the cables.

Imposed Loading

The finished floor shall be capable of supporting a uniformly distributed load of 500 to 1000 Kg. per sq.metre of floor area as specified in data sheet. A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

Finish

The finished floor shall be true to lines and levels and present a neat flush surface.

Vendor Drawing

Vendor shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, vendor shall also submit his calculations for the supporting system with all relevant data assumed, to the Employer's Representative for his approval. Work shall be carried out on approved drawings only.

Fire Proof Doors

Material and Workmanship

The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire. The materials, fabrication and erection of fire proof doors shall confirm to IS: 3614 (Part – 1) . The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained beforehand. Sample approval shall also be obtained from testing authority as per the standard IS: 3614 (Part – 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS: 6687) or stainless steel (conforming to IS:304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two hour fire rating and 46 mm for four hour fire rating.

The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame from zinc coated (16G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three way

latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.

END OF PART

STRUCTURAL STEEL WORK

SCOPE

This specification covers the general requirements for supply where specified, fabrication and delivery at site of structural steel.

This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection and shop painting of structures.

APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and other documents referred to herein, this specification shall govern.

a) Materials

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| i) | IS : 808 | Dimensions for Hot Rolled Steel sections |
| ii) | IS : 814 | Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel |
| iii) | IS : 1161 | Steel Tubes for structural purposes |
| iv) | IS : 1239 | Mild steel tubes, tubulars and other Wrought steel fittings |
| | Part1- | Mild steel tubes |
| | Part2- | Mild steel Tubulars and other wrought steel pipe fittings |
| v) | IS : 1363 | Hexagon Head Bolts, Screws and Nuts of product (Parts 1 to 3) Grade C (Size range M5 toM64) |
| vi) | IS : 1367 | Technical Supply Conditions for Threaded Fasteners All Parts) |
| vii) | IS : 1852 | Rolling and Cutting Tolerances for Hot Rolled Steel Products |
| viii) | IS : 1977 | Structural Steel (Ordinary Quality) |
| ix) | IS : 2062 | Steel for General Structural Purposes |
| x) | IS : 2074 | Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming |
| xi) | IS : 3502 | Steel Chequered Plate |
| xii) | IS : 3757 | High Strength Structural Bolts |
| xiii) | IS : 5369 | General Requirements for Plain Washers and Lock Washers |
| xiv) | IS : 5372 | Taper Washers for Channels |
| xv) | IS:5374 | Taper Washer for I Beams |
| xvi) | IS : 6610 | Heavy Washers for Steel Structures |
| xvii) | IS : 8500 | Structural Steel-micro alloyed (medium and high strength qualities) |

b) Codes OfPractice

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| i) | IS : 800 | Code of Practice for General Construction in Steel |
| ii) | IS : 801 | Code of practice for use of Cold formed light gauge steel structural members in general building construction |

iii)	IS : 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
iv)	IS : 806	Code of practice for use of steel tubes in general building construction
v)	IS : 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
vi)	IS : 822	Code of Procedure for Inspection of Welds
vii)	IS : 1182	Recommended Practice for Radiographic examination of Fusion - Welded Butt Joints in Steel Plates
viii)	IS : 1200	Method of Measurement in Building Civil Engineering Works
ix)	IS : 1477	Code of Practice for Painting of (Parts 1 &2) Ferrous Metals in Buildings
x)	IS : 2595	Code of Practice for Radiographic Testing
xi)	IS : 3658	Code of Practice for Liquid Penetrant Flaw Detection
xii)	IS : 4000	High strength bolts in Steel Structures - Code of Practice
xiii)	IS : 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
xiv)	IS : 7215	Tolerances for Fabrication of Steel Structures
xv)	IS : 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

STEELMATERIALS

Steel materials shall comply with the specifications laid down under clause 2.0 and/or as called for on the design drawings. All materials used shall be new, unused and free from defects. Steel conforming to IS: 1977 shall be used only for the following:

- Fe310-0(St 32-0) : for general purposes such as door/ window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.
- Fe410-0(St42-0) : for structures not subjected to dynamic loading other than wind loads such as:

Platform roofs, foot over bridges, building, and factory sheds etc.

Fe410-0(St42-0) : grade steel shall not be used

- If welding is to be employed for fabrication.
- If site is in severe earthquake zone.
- If plastic theory of design is used.

USE OF STEEL SUPPLIED BY THEPURCHASER

The VENDOR/CONTRACTOR shall use steel supplied by the PURCHASER judiciously

and to the best advantage so as to minimize splicing and wastage. All steel materials remaining after completion of the report, whether in the form of balance pieces or unutilized prime steel, shall be returned to the PURCHASER's stores by the VENDOR/CONTRACTOR at his own cost. An unaccountable wastage upto a maximum of 1% of the fabricated steel will be allowed. This wastage does not include the balance cut lengths/pieces of steel returned to the PURCHASER.

DRAWINGS PREPARED BY THE VENDOR/CONTRACTOR

The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

The VENDOR/CONTRACTOR shall not commence detailing unless ENGINEER's design drawings are officially released for preparation of shop drawings. The VENDOR/CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the VENDOR/CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER.

All fabrication drawings shall be submitted to the ENGINEER for approval.

No fabrication drawings will be accepted for ENGINEER's approval unless checked and approved by the VENDOR/CONTRACTOR's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the VENDOR/ CONTRACTOR only after ENGINEER's approval of fabrication drawings. Approval by the ENGINEER of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The ENGINEER's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

FABRICATION

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/ground smooth true and square where so specified. All holes and edges shall be free of burrs. 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 relevant IS codes for providing standard fabrication tolerance. Material at the shops be kept clean and protected from weather.

Connections

Shop/field connections shall be as per approved fabrication drawings.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose. All connections and splices shall be designed for full strength of members or loads indicated on ENGINEER's design drawings. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws etc. shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

All members likely to collect rain water shall have drain holes provided.

Straightening

All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the ENGINEER in writing. Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

Rolling and Forming

Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

High Strength Friction Grip Bolting

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.

Welding

Welding procedure shall be submitted to ENGINEER for approval. Welding shall be

entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS 817, IS: 7310 (Part 1) and IS: 7318 (Part 1).

While fabricating 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 members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the ENGINEER shall not relieve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces 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 overpeening.

No welding shall be done on base metal at a temperature below -5Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

Inspection of Welds

All welds shall be inspected for flaws by any of the methods described under clause 8 "Inspection". The choice of the method adopted shall be determined by the PURCHASER/ ENGINEER.

The correction of defective welds shall be carried out as directed by the ENGINEER 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 ENGINEER shall be used to ensure that the whole of the crack and material up to 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 VENDOR/CONTRACTOR's account.

Tolerances

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 tolerances for fabrication of structural steel shall be as per IS: 7215.

End Milling

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

INSPECTION

The VENDOR/CONTRACTOR shall give due notice to the PURCHASER/ENGINEER in

advance of the works getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the PURCHASER's/ENGINEER's approval/ inspection. The fact that certain material has been accepted at the VENDOR/ CONTRACTOR's shop shall not invalidate final rejection at site by the PURCHASER/ENGINEER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the PURCHASER may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or despatched to site without inspection and approval by the PURCHASER/ ENGINEER unless such inspection is waived in writing by the ENGINEER.

The VENDOR/CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field 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 ENGINEER.

Inspection and tests on structural steel members shall be as set forth below
Material Testing

If mill test reports are not available for any steel materials the same shall be got tested by the VENDOR/CONTRACTOR to the ENGINEER's satisfaction to demonstrate conformity with the relevant specification.

Tests on Welds

Magnetic Particle Test

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. 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 the permission of the ENGINEER.

Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

Radiographic Inspection

All full strength butt welds shall be radio graphed in accordance with the recommended practice for radiographic testing as per relevant IS code.

Dimensions, Workmanship & Cleanliness

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the VENDOR/CONTRACTOR's approved fabrication drawings and the ENGINEER's drawings.

Test Failure

In the event of failure of any member to satisfy inspection or test requirement, the CONTRACTOR shall notify the ENGINEER or his authorized representative. The VENDOR/CONTRACTOR must obtain permission from the ENGINEER before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the ENGINEER.

The ENGINEER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the PURCHASER, only in case of successful testing.

The VENDOR/CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorized representative.

SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by VENDOR/CONTRACTOR at no extra cost to the PURCHASER.

DRILLING HOLES FOR OTHERWORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost to the PURCHASER. The information for such extra holes will be supplied by the PURCHASER/ENGINEER.

MARKING 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 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt 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 in identical locations. Members having lengths of

7.0 m or more shall have the erection mark at both ends.

ERRORS

Any error in shop fabrication 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 ENGINEER as defective workmanship. In case ENGINEER rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the ENGINEER's requirements by VENDOR/CONTRACTOR free of cost at site.

PAINTING

All the Painting Specifications shall be as the specifications of this document.

METHOD OF MEASUREMENT

For the purpose of payment, the weight of the actual completed structures shall be calculated from the approved drawings for different items of work. The VENDOR/CONTRACTOR shall submit to the PURCHASER relevant material list containing weight of each item.

No allowances will be permitted for bolts, nuts, washers, studs, screws etc, galvanizing, welding or for rolling margins

The weight of a member made out of standard rolled section such as beams, channels, angles, etc. shall be based on the standard IS:808 without deductions for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channels, the full weight of the rolled section shall be considered only if more than half the depth of the original section is used. Otherwise, only half the section unit weight shall be considered for calculation of the weight of the components.

Deductions shall be made in the weight of gussets/plates for cuts and notches of 900 sq. cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams, etc, the area shall be that of the minimum circumscribing rectangle except as stated in 13.3 above.

The weight of any built-up members shall be based on the weight of each component.

ERECTION OF STRUCTURAL STEELWORK

SCOPE

This specification covers the general requirements for erection of structural steel. It covers the supply and delivery of all necessary materials, labour, scaffolding, tools, tackles, equipment and everything that is necessary for the satisfactory completion of the job on schedule. Data Sheet A covers the specific requirements for the project. The two parts are complementary and are to be read together for a correct interpretation of the provisions of this specification. Where requirements of the two sections conflict, those of Data Sheet A shall govern.

APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practice referred to herein shall be the latest editions, including all applicable official amendments and revisions.

In case of discrepancy between this specification and other documents referred to herein, this specification shall govern. In case of discrepancy between tender drawings and this specification, the tender drawings shall govern.

Structural

- (a) IS:800: Code of Practice for General Construction in Steel
- (b) IS:801: Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
- (c) IS:806: Code of Practice for Use of Steel Tubes in General Building Construction
- (d) IS:7205: Safety Code for Erection of Structural Steel Work
- (e) IS:7215: Tolerances for Fabrication of Steel Structures
- (f) IS:4000: High Strength Bolts in Steel Structure - Code of Practice
- (g) AISC: Specifications for Design, Fabrication and Erection of Buildings

ERECTION SCHEME

Each Bid shall be accompanied by a broad erection scheme with dates and estimated completion time for various parts of the work prepared by BIDDER after a thorough study of the Bid drawings and the site conditions. This erection scheme shall describe the methods proposed to be employed by BIDDER for transporting his equipments, tools, tackles, gas cylinders, electrodes and all that is necessary to site, unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components and the type, capacity and quantity of equipment that BIDDER proposes to bring to site for all these operations. The scheme shall also indicate the strength and trade wise composition of the work force and supervisory personnel that will be deployed by BIDDER for the various operations.

ERECTION PROGRAMME

Within two weeks of the acceptance of his Bid, the successful BIDDER shall submit, a detailed erection programme. This programme shall be accompanied by a layout plan identifying the areas proposed for unloading, main storage, subsidiary storage, assembly and the transportation of equipment and fabricated material between the storage and work areas. The layout shall clearly indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc. The locations and extent of site offices and stores, labour quarters if any, layout of electrical cables and water pipes from the tap-off points shall also be indicated in detail on the above layout. Full details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying, etc. shall be furnished by CONTRACTOR in this erection programme along with complete details of the quantity and capacity of the various items of erection equipment that will be used. A site organization chart showing the number of supervisory personnel, and the number and composition of the various gangs shall also

accompany the erection programme.

Any modifications to the erection programme directed by ENGINEER for the reasons of inadequacy of the quantity and/or capacity of the erection equipment, erection personnel and supervisors, temporary bracing, guying etc., or safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies shall be incorporated by CONTRACTOR and the work shall be carried out in accordance with the revised programme. Approval by ENGINEER shall not relieve CONTRACTOR from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by ENGINEER/OWNER. CONTRACTOR shall also make no extra claims for bringing additional equipment to site for erection, if so directed by ENGINEER. CONTRACTOR shall be deemed to have visualized all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

SITE OPERATIONS

An experienced and qualified Superintendent shall be in full time charge of the job.

CONTRACTOR shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

CONTRACTOR shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. CONTRACTOR shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of OWNER/ENGINEER and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain CONTRACTOR's electrical equipment and connections.

CONTRACTOR shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by CONTRACTOR shall be rectified entirely at CONTRACTOR's cost, to the satisfaction of OWNER/ENGINEER. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, CONTRACTOR must ensure suitable safety precautions in consultation with ENGINEER.

If a portion of the work of the project area cannot be made available to CONTRACTOR for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. CONTRACTOR shall work in coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

ACCEPTANCE OF STEEL. ITS HANDLING & STORAGE

Point of delivery of fabricated steel shall be as specified in Data Sheet A.

CONTRACTOR shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of OWNER/ENGINEER.

No dragging of steel shall be permitted. All 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 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 CONTRACTOR well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer specified under Data Sheet A for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

ANCHOR BOLTS & FOUNDATIONS

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 shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to ENGINEER.

Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. 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 M.S. plates and shall be supplied by CONTRACTOR at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by 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 will be carried out by CONTRACTOR, unless the grouting is specifically excluded from the CONTRACTOR'S scope.

ASSEMBLY & CONNECTIONS

Field connections may be effected by riveting, bolting, welding or by use of high strength friction grip bolts as specified in Data Sheet-A and as shown on the design and erection drawings.

All field connection work shall be carried out in accordance with enclosed Data Sheet - A. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by Erector free of cost.

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 to 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 ENGINEER.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to ENGINEER.

ERECTION

All structural steel shall be erected as shown on the drawings. 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 ENGINEER in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls steel or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as directed by ENGINEER. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding.

The erection of chequered plates shall include:

- (a) Welding of stiffening angles/vertical stiffening ribs
- (b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through
- (c) Splicing as shown in relevant drawing
- (d) Smoothing of edges
- (e) Fixing of chequered plates by tack welding or by countersunk bolts
- (f) Providing lifting hooks for ease of lifting.

As erection progresses, the work shall be securely bolted 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 ENGINEER. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of ENGINEER.

Test certificates as specified in Data Sheet A shall be furnished by CONTRACTOR.

INSPECTION

ENGINEER/OWNER or their authorized representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at CONTRACTOR's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by ENGINEER.

TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

Columns

Deviation of column axes at foundation top level with respect to true axes:

- (a) In longitudinal direction : $\pm 5\text{mm}$
- (b) In lateral direction : $\pm 5\text{mm}$

Deviation in the level of bearing surface of columns at foundation top with respect to true level: $\pm 5\text{mm}$

Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:

- a) For columns upto and including 15 metres in height : $\pm 1/1000$ of column height in mm or $\pm 15\text{mm}$ whichever is less
- b) For columns exceeding 15 metres in height : $\pm 1/1000$ of column height in

Deviation in straightness in longitudinal and transverse planes of column at any point along the height : $\pm 1/1000$ of column height in mm or $\pm 10\text{mm}$ whichever is less

Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams : $\pm 10\text{mm}$

with respect to true distance

Deviation in any bearing or seating level with respect to true level ± 5 mm

Deviation in differences in bearing levels of a member on adjacent pair of columns both across and along the Building ± 10 mm

Trusses and Beams

Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord $\pm 1/250$ of height of truss in mm or ± 15 mm whichever is less

Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss $\pm 1/1500$ of span of truss in mm or ± 15 mm whichever is less

Lateral shift in location of truss from its true vertical position ± 10 mm

Lateral shift in location of purlin true position ± 5 mm

Deviation in difference of bearing levels of trusses or beams from the true difference

- i) ± 20 mm for trusses
- ii) For beams:
Depth < 1800mm : ± 6 mm
Depth > 1800mm : ± 10 mm

Deviation in sag in chords and diagonals of truss between node points $1/1500$ of length in mm or 10mm whichever is smaller

Deviation in sweep of trusses, beams etc. in the horizontal plane $1/1000$ of span in mm subject to a maximum of 10 mm

PAINING

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 in Data Sheet A. Before paint

is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

METHOD OF MEASUREMENT

CONTRACTOR shall submit to OWNER relevant material list containing weight of each item.

No allowance will be permitted for weights of rivets, bolts, washers, screws etc. in calculating the weight of the completed structure. No allowances will be permitted for galvanizing, welding or for rolling margins.

The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channel, the full weight of the rolled section shall be considered only if more than half the depth of the section is used. Otherwise only half the section unit weight shall be taken. Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm or larger.

For gussets/plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated in clause 13.3 above.

The weight of any built-up member shall be separated into the weight of each component.

Erection bolts installed by erector may be left in position on completion of erection; however, no additional payment shall be made either for supply or use of such bolts. If erection bolts are removed after erection is complete, holes shall be plug welded and ground smooth. No extra payment shall be made for such plug welding.

CLEAN UP OF WORKSITE

During erection, the CONTRACTOR shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to OWNER/ENGINEER.

SCOPE PAINTING

This specification covers the general requirements for painting structural steel work involving the supply and delivery of all necessary materials, labour, scaffolding, tools and equipment. This document covers the aspects of surface treatment, application of primer paint and finish painting.

APPLICABLE CODES AND SPECIFICATIONS

The following Standard Specifications and Codes of Practice are made a part of this Specification. All standards and codes referred to herein shall be the latest editions

including all applicable official amendments and revisions.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

IS: 110: Ready Mixed paint, brushing, grey filler for enamels for use over primers.

IS: 158: Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, alkali and heat resisting.

IS: 159: Ready Mixed paint, Brushing, Acid resisting.

IS:341 Black Japan, Types A, B and C

IS:1477 Codes of Practice for painting of ferrous metals in buildings. Part I -Pre-treatment

Part II - Painting

IS:2074 Ready Mixed paints, Red Oxide

Zinchrome priming. IS:2339 Aluminium paint for general purposes, in

Dual container IS:2932 Specification for enamel, synthetic, exterior, type 1,

(a) Undercoating, (b) finishing

IS:2933 Specification for enamel, exterior, type 2,

(a) Undercoating, (b) finishing

IS:5905 Sprayed aluminium and zinc coatings on Iron and Steel.

IS:6005 Code of practice for phosphating of Iron and Steel.

IS:9862 Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.

IS:13183 Aluminium paint, Heat resistant.

IS:13607 Ready Mixed paint, Finishing, general purposes, to Synthetic specification

SIS-05-5900 Swedish Standard

SURFACE TREATMENT

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The type of surface treatment shall be as specified in the respective item of work. The workmanship shall generally conform to the requirements of IS 1477-Part I.

Oil and grease removal shall be carried out either by solvent cleaning or by using alkali type degreasing agents. To remove grease material the surface shall be cleaned with solvents containing emulsifier. After cleaning, the surface shall be washed with water. When the surface has cement pelts or salts, the cleaning shall be done with strong alkalies. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried out to ensure that no traces of alkali are left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions. Derusting and descaling of steel shall be carried out either manually, mechanically or chemically.

Manual or Hand Tool Cleaning

Loose mill scale, loose rust and loose paint shall be removed by wire brushing, scrapping, chipping and rubbing with abrasive paper or steel wool. This method shall not be employed when the surface has firmly adhering mill scale. After hand tool cleaning, the surface shall be rubbed with sand paper so as to ensure that no loose material exists and the surfaces shall be dusted off.

Mechanical Cleaning

Power Tool Cleaning

This shall be carried out by employing power operated wire brushes. Power tool cleaning shall be resorted to only if sand/shot blasting is not possible/ permissible and high quality of surface preparation is required.

The surface prior to such cleaning shall be cleaned of dust, grease, etc. and heavier layers of rust shall be removed by chipping.

The power tool cleaning shall remove loose mill scale and rust by adopting very thorough scrapping, grinding and machine brushing. After the surfaces are cleaned by compressed air, it shall have a pronounced metallic sheen.

Flame Cleaning

Hard mill scale and rust shall be removed through Oxy- acetylene flame. The work shall be carried out by trained workmen to ensure that only mill scale is removed without affecting the parent steel. The work shall be carried out carefully on welded surfaces so that the strength of weld is not affected due to heating.

Sand Blasting And Shot Blasting

Sand/shot blasting shall be resorted to only after removal of grease, oil and other contaminants. The work shall be carried out by impinging under pressure of air, a jet of sharp sand or granulated steel (steel grits) on to the metal surface. The process shall ensure complete removal of rust and firmly adhering mill scale. Special care shall be taken on weld areas to remove flux and spatter. Blasting shall ensure an even colour of the surface and the surface shall have silver grey colour. Precautions shall be taken when sand or shot blasting of light gauge steel surfaces to ensure that buckling does not occur to continuous impingement of sand or steel shots under high velocity.

Sand/shot blasting shall be adopted for structures which are exposed to corrosive conditions for which superior paint protection is to be adopted. The finished surfaces shall conform to the requirements of Sa 2½ or Sa 3 as per Swedish Standard SIS-05-5900 as specified in the item of work.

As Sandblasting causes dust nuisance necessary clearance shall be obtained by the CONTRACTOR from Competent authorities prior to commencing Sand blasting.

Chemical Cleaning (Pickling)

The cleaning shall be done by pickling in sulphuric, hydrochloric or phosphoric acids.

Pickling shall be carried out in accordance with detailed procedure as given in IS 6005. Washing after pickling shall remove all traces of the acids. All work pieces shall be thoroughly inspected and in particular the inaccessible corners.

MATERIALS

Primer Paint

Anti-corrosive primers shall be either lead based or lead free types. Red lead primer shall conform to relevant Indian Standards and red oxide zinc chrome primer shall conform to IS2074.

Finish Paint

Synthetic enamel painting for undercoat and finish coat shall conform to IS 2932/ IS 2933.

Acid, alkali and heat resistant bituminous paint shall conform to IS 158.

Acid, alkali, water and chlorine resisting bituminous paint shall conform to IS 9862.

Heat resistant aluminium paint shall conform to IS 13183.

Epoxy primer and epoxy paint shall be of the type as specified in the item of work from an approved manufacturer.

Chlorinated rubber based paint shall be of the manufacture as specified or any equivalent approved manufacture.

All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/ shade prior to procurement for usage in the works.

Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.

The color and shade shall conform to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade/number from the alternatives available, CONTRACTOR shall adopt trial painting in small patches in consultation with and as directed by the ENGINEER.

All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically directed by the ENGINEER.

Paints shall be stirred thoroughly to keep the pigment in suspension.

CONTRACTOR shall at his own cost arrange for testing of paints as per relevant Indian Standards in standard laboratory whenever OWNER wants the tests to be carried out for each batch of paints. Test results shall be submitted to the OWNER for obtaining approval.

WORKMANSHIP

The type and the number of coats of the primer paint and finish paint shall be as specified in the respective items of work.

Painting shall be carried out only on thoroughly dry surfaces.

No painting shall be done in frosty/ foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 5°C or lower.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

The application of paint film shall serve the twin purpose of protecting the steel from corrosion and giving the decorative appearance. A paint, which gives the steel adequate protection over a long period together with good appearance shall therefore be adopted. Workmanship shall generally conform to requirements specified in IS: 1477-Part II.

It is essential to ensure that immediately after preparation of the surfaces; the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film without "holidays". After the first coat becomes hard dry a second coat of primer shall be applied by brushing to obtain a film free from holidays.

Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces of the first coat during transport from shop to site and during erection shall be provided with a touch-up coat of the primer.

The dry film thickness of each coat of primer shall be not less than 25 microns.

Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection to the steel surface over a long duration.

Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Fillers prepared by whiting and linseed oil by craftsmen at site shall never be used as such fillers may be unbalanced and incompatible with primer and finishing coats. Application of filler shall be done with good 'putty knife' and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, due as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the under coats also.

Painting shall be carried out either by brushing or by spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.

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 paint of optimum thickness shall be applied by brushing/ spraying 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 finishing coat of paint shall be applied by brushing or by spraying 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 or by spraying.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER.

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.

The thickness of film shall be measured by an Elcometer to be supplied by the CONTRACTOR. The CONTRACTOR shall calibrate the Elcometer frequently for different settings. Necessary calibrating accessories should be kept ready for calibration/testing of Elcometer at anytime.

Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Portion of steel members embedded/to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall receive the painting as specified.

Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, and peeling, blistering and rusting. The breakdown of a paint film is progressive from the top finish paint to the primer coat and the object of maintenance painting is to renovate periodically to effectively check the breakdown and protect the steel surfaces from corrosion. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause. 7 of IS 1477-PartII.

CONTRACTOR shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls etc.

DESIGN BASIS FOR DISTRIBUTION SYSTEM

WATER DISTRIBUTION SYSTEM

Pipe Material	Ductile Iron (K-9 Class)
Residual Pressure	5 m
Minimum Cover	1 m

STRUCTURAL SPECIFICATION FOR PWT/PWWTP

LOADS

The structures are designed for the following loads.

Dead Loads

The dead loads to be considered in design of structures are based on following density of materials as per IS-875(Part-I)-1987

Parameter	Value
Density of water	10 kN/m ³
Density of Plain Concrete	24 kN/m ³
Density of Reinforced Concrete	25 kN/m ³
Weight of brickwork (exclusive of plaster)	22.00 N/m ² per mm thickness of brickwork
Weight of sand (filter media)	26.0 kN/m ³
Weight of alum blocks	24.20 kN/m ³

Live Loads

The live loads considered for the design are as per IRC: 875(Part-II)-1987 and are as follows.

Parameter	Value
Live load on roofs	1.50 kN/m ²
Live load on floors supporting equipment such as pumps, blowers, compressors, valves etc.	10.00 kN/m ²
Live load on all other floors walkways, stairways and platforms	5.00 kN/m ²

Wind Loads

Wind load on the structure is IS: 875 (Part-III)

Seismic Loads

Ahmedabad falls in Zone III of Seismic map of India given in IS-1893-2000(Part-I).

Combination of Load Cases

Combination of the above loads are carried out as IS: 456-2000.

DESIGN

- a. Design of all Reinforced Concrete members are as per IS: 456-2000 & IS-3370:2009. Working Stress method is used for the design of all water retaining components.
- b. All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

GRADE OF CONCRETE AND REINFORCEMENT

The following grade of concrete and steel shall be used:

- a. For Water Retaining Structures – M30concrete
- b. For other Structures – M25concrete
- c. For all Structures – Fe 500 -reinforcement

CLEAR COVER TO REINFORCEMENT

The minimum clear cover to reinforcement shall be as follows:

- a. For All Water Retaining Structures (Walls, Columns, Beams, Slab, Base Slab etc)
–50mm
- b. The minimum cover to the main reinforcing bars for different members for non– water

retaining structures shall be as follows unless stated other wise:

Slab (Floor, Roof, Canopy and Staircase)	30mm
Beams (Sides, Bottom & Top)	40mm
Columns	50mm
Pedestals (in contact with earth)	50mm
Basement wall, retaining walls	
i) Face in contact with earth	40mm
ii) Interior face	30mm
Foundations	50mm

Design Conditions for Underground or Partly Underground Liquid Retaining Structures

For design of all structures, water level is assumed as per geotechnical investigation report. All underground or partly underground liquid containing structures shall be designed for the following conditions:

- (i) Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered;
- (ii) structure empty (ie., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered;
- (iii) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall;
- (iv) partition wall between two compartments : to be designed as one compartment empty and other full;
- (v) structures shall be designed for uplift in empty conditions with the water table as indicated in geotechnical report;
- (vi) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
- (vii) Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation.
- (viii) All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

SAFE BEARINGCAPACITY

The data referred to the safe bearing capacity of the soil is obtained from the soil investigation report and are as follows:

At 2m below Ground Level- Assumed Safe Bearing Capacity of soil shall be 15 t/m².

WATER DISTRIBUTION SYSTEM & TREATED WASTE WATER TRANSFER SYSTEM

WATER DISTRIBUTION SYSTEM & TREATED WASTE WATER TRANSFER SYSTEM

This specifications chapter covers manufacture, supply, transport, handling, stacking, laying, jointing, testing and commissioning of Ductile Iron pipelines and specials for Clear water distribution system and treated waste water transfer system.

APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to. Standards except as otherwise specified in this technical specification, the Indian/International Standards and Codes of Practice in their latest version shall be adhered to. Should any product be offered conforming to other standards, the equipment or products shall be equal to or superior to those specified and the documentary confirmation shall be submitted for the prior approval of the Engineer. This specification requires a reference to the following standard specifications

IS: 10500-1991	Drinking water specification
IS: 3400-1995	Methods of test for vulcanised rubber (part-1 to 22)
IS: 1387-1993	General requirements for the supply of metallurgical material
IS: 1367-2002	Technical supply conditions for threaded steel fasteners
IS: 14846-2000	Sluice valve for water works purposes (50 to 1200 mm)
IS: 318-1981	Leaded tin bronze ingots and casting
IS: 7181-1986	Horizontally cast iron double flanged pipes for water, gas and sewage.
IS: 5382 -1985	Rubber sealing rings for gas mains, water mains and sewers
IS: 779-1994	Water meters
IS: 3624-1987	Pressure and vacuum gauges
IS: 341-1973	Black japan, types A, B and C
IS: 9862-1981	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS: 1239-2004	Mild steel tubes, tubular and other wrought steel fittings
IS: 778-1984	Specifications for copper alloy gate, globe and check valves for water works purposes

IS: 12820-2004	Dimensional requirements for rubber gaskets for mechanical joints and push on joint for use with cast iron pipes and fittings for carrying water, gas and sewage.
BSNL	Bharath Sanchar Nigam Limited; Technical specifications for cable ducts.
IS 9523-2000 / BS: EN545	Specification for DI fittings
IS: 8329-2000	Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage.
IS: 12288-1987	Code of practice for use and laying of ductile iron pipes
CPHEEO	Manual on Water Supply and Treatment, III edition, Ministry of Urban Development, New Delhi- May 1999.

DUCTILE IRON PIPES

Pipes

The pipes will be centrifugally cast (spun) Ductile Iron pipes for Water conforming to the IS 8329: 2000. The pipes used will be either with push on joints (Rubber Gasket Joints) or Flanged joints. The class of pipe to be used shall be of the class K-9.

The pipes shall be coated with bitumen as per appendix C and have factory provided cement mortar lining in the inside as per the provisions of Appendix B of the IS 8329: 2000.

The pipes will be supplied in standard length of 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety will also be supplied with a rubber EPDM gasket. Any change in the stipulated lengths will be approved by the Engineer – in charge. The gaskets will confirm to the IS 5382:1985 and IS: 12820-2004.

The specials and gaskets should also be supplied by the manufacturer of the pipes. It should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub contractor's premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

The flanged joints will confirm to the Clause 6.2 of IS 8329-2000. The pipe supply will also include one rubber gaskets for each flange.

Inspection and Testing

The pipes will be subjected to following tests for acceptance:

- Visual and dimensional check as per Clause 13 and 15 of IS 8329-2000
- Mechanical Test as per Clause 10 of IS 8329-2000
- Hydrostatic Test as per Clause 11 of IS 8329-2000

The test reports for the rubber gaskets shall be as per acceptance tests of the IS 5382-1985 and will be in accordance to Clause 3.8.

The sampling shall be as per the provisions of the IS 8329 -2000.

Marking

All pipes will be marked as per Clause 18 of IS 8329-2000 and show as below:

- Manufacturer name/stamp
- Nominal diameter
- Class reference
- A white ring line showing length of insertion at spigot end

SPECIALS FOR DUCTILE IRON PIPES

General

This section covers the general requirements for Ductile Iron (DI) fittings suitable for Tyton joints to be used with Ductile Iron pipes with flanged and Tyton jointing system.

Types of specials

The following types of DI fittings shall be manufactured and tested in accordance with IS: 9523-2000 or BS: EN 545.

- a. Flanged socket
- b. Flanged spigot
- c. Double socket bends (900, 450, 22 1/2 0, 11 1/40)
- d. Double socket branch flanged tee
- e. All socket tee.
- f. Double socket taper.
- g. All flanged tee.
- h. All flanged taper.

Specials

All the DI fittings shall be supplied with one rubber ring for each socket. The rubber ring shall conform to IS: 12820-2004 and IS: 5382 -1985 as described in the preceding chapter. Flanged fittings shall be supplied with one rubber gasket per flange and the required number of nuts and bolts.

LUBRICANT FOR DUCTILE IRON PIPES AND SPECIALS

General

This section covers the requirements for lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-in rubber ring joints

Specification

The lubricant has to have the following characteristics:

- a. Must have a paste like consistency and be ready for use
- b. Has to adhere to wet and dry surfaces of DI pipes and rubberrings
- c. To be applied in hot and cold weather; ambient temperature 0 - 50°C, temperature of exposed pipes up to 70°C
- d. Must be nontoxic
- e. Must be watersoluble
- f. Must not affect the properties of the drinking water carried in the pipes
- g. Must not have an objectionable odour
- h. Has to inhibit bacterial growth
- i. Must not be harmful to the skin
- j. Must have a shelf life not less than 2 years
- k. Acceptance tests
- l. They shall be conducted in line with the provisions of the IS 9523-2000

APPLICABLE CODES

Standards except as otherwise specified in this technical specification, the Indian/international standards and codes of practice in their latest version shall be adhered to for the design, manufacturing, inspection, factory testing, packing, handling and transportation of product. Should any product be offered conforming to other standards, the equipment or products shall be equal to or superior to those specified and the documentary confirmation shall be submitted for the prior approval of the engineer.

This specification requires a reference to the following standard specifications. In case of any discrepancy this specification shall govern.

IS: 10500-1991	Drinking water specification
IS: 3400-1995	Methods of test for vulcanised rubber (part-1 to 22)
IS: 1387-1993	General requirements for the supply of metallurgical material
IS: 1367-2002	Technical supply conditions for threaded steel fasteners
IS: 14846-2000	Sluice valve for water works purposes (50 to 1200 mm)
IS: 318-1981	Leaded tin bronze ingots and casting
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IS: 779-1994	Water meters
IS: 3624-1987	Pressure and vacuum gauges
IS: 341-1973	Black japan, types A, B and C

IS: 9862-1981	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS: 1239-2004	Mild steel tubes, tubular and other wrought steel fittings
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IS: 12820-2004	Dimensional requirements for rubber gaskets for mechanical joints and push on joint for use with cast iron pies and fittings for carrying water, gas and sewage.
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IS: 12288-1987	Code of practice for use and laying of ductile iron pipes
CPHEEO	Manual on Water Supply and Treatment, III edition, Ministry of Urban Development, New Delhi- May 1999.

PACKING FOR DISPECIALS

All the DI fittings shall be properly packed with jute cloth. Rubber rings shall be packed in polyethylene bags. Rubber rings in PE bags and nuts, bolts etc. shall be supplied in separate jute bags. The fittings should also be supplied by the manufacturer of the pipes. They should preferably be manufactured by the manufacturer of the pipes. In case they are not, it will be the responsibility of the manufacturer of the pipes to have them manufactured from a suitable manufacturer under its own supervision and have it tested at his/sub contractors premises as per the contract. The pipe manufacturer will however be responsible for the compatibility and quality of the products.

LAYING AND JOINTING OF PIPES

General:

Laying and jointing will be as per IS 12288. The pipes will be cleaned in the whole length with special care of the spigot and sockets on the inside/ outside to ensure that they are free from dirt and unwarranted projections. The whole of the pipes shall be placed in position singly and shall be laid true to profile and direction of slope indicated on longitudinal sections. The pipes shall be laid without deflection in a straight alignment between bends and between high and low points. Vertical and horizontal deflections between individual pipes need the approval of the Engineer in Charge. In no case the deflection shall be more than 75 % of those recommended by the manufacturer.

Before pipes are jointed they shall be thoroughly cleaned of all earth lumps, stones, or any other objects that may have entered the interior of the pipes, particularly the spigot end and the socket including the groove for the rubber ring. The Contractor shall not leave a gap for fittings and shall lay line in a continuous stretch.

Pipes and the related specials shall be laid according to the instructions of the

manufacturers and using the tools recommended by them.

Cutting of pipes shall be reduced to a minimum required to conform with the drawings. Cutting has to be made with suitable tools and according to the recommendations of the manufacturer. The spigot end has to be chamfered again at the same angle as the original chamfered end. Cutting shall be perpendicular to the centre line of the pipe. In case of ductile iron pipes the cut and chamfered end shall be painted with two coats of epoxy paint. If there is no mark for the insertion depth on the spigot ends of the (cut) pipe it shall be marked again according to the instructions of the manufacturer.

Before pipes are jointed they shall be thoroughly cleaned of all earth lumps, stones, or any other objects that may have entered the interior of the pipes, particularly the spigot end and the socket including the groove for the rubber ring. End caps are removed only just before laying and jointing.

All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. The Contractor has to ensure that the specials and accessories are ready in time to be installed together with the pipes.

At the end of each working day and whenever work is interrupted for any period of time, the free ends of laid pipes shall be protected against the entry of dirt or other foreign matter by means of approved plugs or end caps.

When pipe laying is not in progress, the open ends of installed pipe shall be closed by approved means to prevent entrance of trench water and dirt into the line.

No pipe shall be laid in wet trench conditions that preclude proper bedding, or when, in the opinion of the Engineer in Charge, the trench conditions or the weather are unsuitable for proper installation.

The pipe line laid should be absolutely straight unless planned otherwise. The accuracy of alignment should be tested before starting refilling with the help of stretching a string between two ends of the straight stretch of pipes to rectify possible small kinks in laying.

- **Laying and jointing of DI pipes and fittings:** Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

All construction debris should be cleared from the inside of the pipe either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. All persons should vacate any section of trench into which the pipe is being lowered.

On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position while the trench is back filled over the barrel of the pipe.

The designed anchorage shall be provided to resist the thrusts developed by internal

pressure at bends, tees, etc.

Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline.

The assembly of the pipes shall be made as recommended by the pipe manufacturer and using the suitable tools.

The socket and spigot ends of the pipes shall be brushed and cleaned. The chamfered surface and the end of the spigot end have to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material which may damage the rubber gasket shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.

The two pipes shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the assembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade.

Deflection of the pipes -if any- shall be made only after they have fully been assembled. The deflection shall not exceed 75 % of the values indicated by the pipe manufacturer.

- **Pillars for ductile iron pipes:** In case of unstable subsoil or in case of ductile iron pipes laid above ground they shall be laid on pillars. Each pipe is supported at the plain end and behind the socket. One pillar shall support the socket end of one and the plain end of the other pipe. The pillars shall be of Cement Concrete and shall be founded on solid soil, not subject to erosion by wind or water. The foundation of the pillars has to be calculated according to the soil conditions.

The top of the pillar shall form two saddles for the pipe having the same radius as the pipe. The socket will be lying free between the two saddles. The pipes shall be laid on a coat of polyethylene of 2 mm thickness, put on mortar. It has to be ensured that the spigot end of the pipe is supported by the saddle and does not unduly compress the rubber ring in the lower part. Each pipe is fixed by one adjustable galvanised steel spanner, fixed to the pillar with anchor bolts.

In case of vertical deviations the pipes shall be protected against uplift by additional reinforced clamps of mild steel. In this case, the design of the pillar has to be made taking in account these uplift forces and design will be given by ENGINEER.

NOTES

If any damage is caused to the pipeline during the execution of work or while cleaning / testing the pipeline as specified, Contractor shall be held responsible for the same and shall replace the damaged pipeline and retest the same at his own cost to the full satisfaction of Engineer.

Water for testing of pipeline shall be arranged by Contractor at his own cost.

MECHANICALSYSTEM

PUMPS:

General

All the pumps shall be Horizontal Split Casing Centrifugal type and shall be suitable for pumping Raw/Treated Water.

The pumps shall be suitable for highest suction lift encountered. Necessary NPSH curves shall be submitted. The pumps shall be suitable for satisfactory operational for the duty conditions, the head range stipulated above and parallel operation at all water level conditions.

Pump Characteristic:-

Specific speed and discharge power characteristics of pump shall be suitable for starting the pump with closed sluice valve without drawing excess power. Speed shall not be more than 1500 rpm (Synchronous).

The pumps shall have stable characteristics over the entire range of working head.

Pump Construction:

The pump shall be single stage double suction type. The pump shall be horizontal-centrifugal axial split casing non-pullout double suction pump.

The casing of the pump used for raw water supply to RO plant, shall be of SS 304.

The casing of the pump used for treated water distribution, shall be of CI IS210 Gr. 220.

The casing shall be provided with priming funnel and air release vent, Tapping shall be provided for installing suction and delivery pressure gauges.

Each pump should be provided with combination gauge on suction side and suitable pressure gauge on delivery side.

Gland leakage shall be laid to the channel provided in the pump house by bleeding G.I. pipes.

Impellers

Impeller shall be double suction enclosed type, and balanced both statically and dynamically.

Renewable wearing rings shall be provided on both impeller and casing.

Impellers shall be of SS 316 grade.

Pump Shaft:-

The shaft shall be of one-piece construction solid type and will be designed to take all types of loads such as torsion, tensile, bending and dynamic etc. The pump shaft shall be hard chrome plated steel or alloy steel (SS-410) as per manufacturer's standard. Sleeves shall be of stainless steel.

Pump Bearings

Pump bearings shall be of the antifriction type. The bearings shall be able to take normal thrust loads due to unbalanced hydraulic loads on the impellers plus the weight of all rotating parts of the pumps. Pump bearings shall be designed with a minimum life of 40,000 hours. The bearings shall be grease lubricated for life and shall be maintenance free.

Flexible Coupling:-

The pump shaft shall be coupled to motor shaft through flexible coupling. The coupling shall comprise pin and rubber bushes. Each half shall be statically and dynamically balanced for transmission of the power without vibration and shall be keyed to respective shaft. The coupling halves shall have precise machined surfaces for facilitating alignment. Suitable guard for coupling shall be provided.

Base Plate (Base Frame):-

The pump and motor shall be installed on common base plate, to accommodate both pump and motor. Suitable machined sole pieces shall be welded on top of base plate for mounting pump and motor. The base plate shall be constructed from steel channels. The base plate shall be fabricated and supplied by pump manufacturer only. The base plate shall be offered for inspection during factory test of pump.

Material of Construction:-

Sr. No.	Description	Materials
1A	Casing (Raw Water Supply)	SS 304
1B	Casing (Treated Water Supply)	CI IS210 Gr.220
2	Impeller	SS 316
3	Pump shaft	SS 410
4	Sleeves	Stainless steel. 410
5	Base Plate	ISMC.

Foundation and Installation:-

The pumping machinery contractor shall select the suitable places for foundation. Foundations shall be cast in 1:2:4 R.C.C. suitable to withstand the static and

dynamic load of pump. Construction of foundation blocks shall be such that pumps house floor will not be disturbed, and if disturbed the same shall be made good to original finish by pumping machinery contractor.

The pumping machinery contractor shall anchor base plate on such foundation with suitable foundation bolt and pipe sleeve with proper leveling and grouting. Required shims / wedges will be provided by the contractor.

The leveling of pump motor shall be checked by dial gauge, feeler gauge and straight edge.

Fasteners

All pump fasteners shall be of SS 304.

Foundation Nuts and Bolts

S.S. foundation nuts and bolts shall be provided.

Protective Coating

The pumps shall be epoxy painted.

Pump Balance

All rotating parts shall be statically and dynamically balanced as per the relevant standards.

Equipment Testing

Each major component of the pumping equipment shall be subjected to shop tests by the pump manufacturer and corresponding test reports / certificates shall be furnished by him along with supply documents of the pump.

Pumps:

Each assembled pump shall be shop tested by the manufacturer to determine the following characteristics within the operating range as specified.

Head capacity curve,

- Brake horse power curve,
- Efficiency curve, total power consumed,

Vibration, (bare pump on no load),

Balancing (impeller and coupling only).

All the tests shall be conducted in accordance with the relevant I.S. / manufacturer's testing standards.

Each pump performance test shall be documented by obtaining concurrent readings showing motor voltage and amperage, pump suction Head and pump discharge

Head. Such readings shall be documented for at least 5 pumping conditions. One test shall be at the shut off Head.

Test Certificates

In addition to the above tests / test certificates, manufacturer will also conduct and furnish test certificates for the following:

- Hydrostatic test on casing,

Material test certificates for major components certifying the grades of the materials used.

Scope of supply

- Horizontal split Casing Pump.
- Horizontal Foot Mounted motor for above Pump
- Base Frame.
- Pump – Motor Coupling.
- Foundation Bolts.
- Pressure Gauges with cocks and tubes.

HORIZONTAL FOOT MOUNTED MOTORS:

Horizontal foot mounted motor shall be of 0415 KV for treated water pumps.

General:-

The tenderer shall provide 3.3 KV and 0.415kV squirrel cage motors for driving treated water pumps. The motors shall confirm to I.S. 325. The contractor shall have to supply winding data of motor duly signed by manufacturer.

The motors shall be suitable for voltage variations of 10 % frequency variation of and combined variation of 10 % and speed 1000 RPM and 1500 RPM (synchronous) respectively.

The torque speed and current speed characteristics of the motors shall be suitable to accelerate the driven equipment to full speed without exceeding the limit of starting current at full load current.

Design:-

The rated power of the motor shall be at least 15 % above the maximum power required over rated head range of pump however output rating shall not be less than 280 kW 140 kW respectively.

The starting time and locked rotor with stand time under hot condition shall have suitable discrimination for proper selection of protection relay.

The locked rotor with stand time under hot condition and at 110 % rated voltage shall be more by at least 3 second than the starting time with driven equipment coupled and at 85 % rated voltage.

The motors shall be suitable for restricted operation at following conditions.

- i) Accelerating the driven equipment from stand still to full speed within duration of 1 minute or less than at 85 % of rated voltage.
- ii) Operation on load at 75% of rated voltage for 5minute
- iii) Two starts in quick succession from cold condition.
- iv) One hot restart at maximum steady state temperature over ambient temperature of 48⁰C.
- v) Three starts per hour equally spreaded over the duration after attaining thermal equilibrium.

The class of insulation of the motor shall be minimum B class. However, temperature rise of the motor when operating at extreme conditions of voltage and frequency variation shall not exceed 60 by thermometer and 70⁰ by resistance over an ambient temperature of 48⁰ at site,

Construction:-

The motors shall be foot mounted, horizontal solid shaft. The rotor shall be statically and dynamically balanced and critical speed shall not be in the range of 80% to 120 % of the motor speed.

The motors shall be screen protected drip proof construction with degree of enclosure protection conforming to IP 23 or superior and having heavy duty anti friction bearing grease lubricated type.

The cable box shall be phase segregated and with degree of protection conforming to IP 54 The terminal box shall be suitable for termination of power cables as per cable size required. Thrust bearing shall be incorporated in the motors. The motor shall have 15 % margin of overloading.

Recommended makes for motors– Kirloskar, Siemens, BHEL, Jyoti.

SLUICEVALVES

Design Requirements

Sluice valves shall generally conform to IS 14846. Body of the valve shall be designed for 1.5 times the rating of the valve. Valves shall be free from sharp projections, which are likely to catch and hold stringy materials. The pressure drop across valve shall be limited to 0.05 mwc. Valve flange faces shall be parallel to each other and flange face should be at right angle to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of bolt head and nut.

Features of Construction

Valves shall have non-rising spindle. Valves shall have a back seating arrangement for replacement of packing without leakage. The valve shall incorporate

an intermediate valve gear box connecting valve spindle to the actuator. Flanges shall be drilled as per BS 4504 (16 bar rating). Valves shall be provided with shoe and channel arrangement. The gap between shoe and channel shall not exceed 1.5 mm. Valves shall be with gear arrangement so that force required on hand wheel shall be limited to 7 kg. Direction of closing the valve shall be clockwise.

Materials of Construction

- (a) Body : CI IS 210 Gr. FG220
 - (b) Wedge : CI IS 210 Gr. FG220
 - (c) Spindle : SS Conforming to BS 970, Gr. 304S11
 - (d) Wedge rings : Bronze to IS: 318 Gr.LTB2
 - (e) Wedge nut : Bronze to IS: 318 Gr.LTB2
 - (f) Internal Hardware : SS316
 - (g) External Hardware : SS304
- Design parameters
- (a) Rating (bar) : PN1.0

BUTTERFLYVALVES

Design Requirements

Butterfly valves shall be as per IS:13095 / equivalent international standard, tight shut off, wafer type, with double eccentricity.

The time from fully open to fully closed position and vice versa shall be limited to about 2½ minutes. The valve shall be suitable for controlling flows by throttling.

Features Of Construction

The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

Valve shall be suitable for throttling purpose.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel.

The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the disc by tapered stainless steel cotter pins. Self lubricating PTFE faced bearings with 'O' ring seals shall be provided.

The valve seat shall be of integrally cast or replaceable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

Valves shall be provided with position indicator to show the position of the disc, mounted on the driven shaft end.

All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valves shall be provided with suitable stops to prevent movement of the shaft beyond the limits corresponding to fully open and fully closed position of the disc.' Valve of diameter 600 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400N.

Rubber sealing ring shall preferably attached to disc edge by means of sectional retaining ring.

Flanges shall be as per BS 4504 (16 bar rating).

Materials of Construction

Body	:	CI to IS 210 Gr FG220
Disc	:	CI to IS 210 Gr FG220
Shaft	:	SS AISI410/431
Body Seat Ring	:	SS AISI410/316 / CF8M
Seal	:	EPDM Rubber
Seal Retaining Ring:		SS AISI304

Design parameters
Rating (bar) : 16

NON RETURN VALVE

Design Requirements

Non-return valve shall be as per IS 5312. The valves shall be suitable for mounting on horizontal pipeline. Valves shall be quick closing type with non-slam characteristics. Hydraulic passage and doors shall be designed to avoid cavitations. The pressure drop in the valve at design flow shall be limited to 0.3mwc.

Valves shall be free from sharp projections, which are likely to get clogged with stringy materials. The internal parts shall be easily accessible for inspection through inspection hole.

Features of Construction

Valves shall be of swing check type. Valves shall be quick closing type with non-slam characteristics. In case of swing type, the non-slam characteristics shall be achieved by providing suitable combination of door and hydraulic passages without any external damping arrangement, or counter weights.

Flow direction shall be clearly embossed on the valve body. Valve flange faces shall be parallel to each other and shall be right angle to valve centerline.

Flange back shall be machine drosspotted for proper seating of bolt head and nut. Flanges shall be drilled as per BS 4504 (16 barrating).

The internal parts shall be easily accessible for inspection through inspection hole.

Valve body shall be designed for 1.5 times the rated pressure.

The pressure rating of valve shall be minimum PN 1.6

Materials of Construction

(a) Body and Doors : Cast Iron: IS 210 Gr. FG200

(b) Body/Door Ring : Bronze IS: 318 Gr.LTB2

(c) Hinge pin : Stainless Steel AISI410

(d) Internal Hardware : SS316

(e) External Hardware : SS304

Design parameters
(a) Rating (bar) : 16

DISMANTLING JOINTS

Design Requirements

Dismantling joint shall be designed such that adequate space can be created by

collapsing the dismantling joint, for removal and for reinstallation of adjacent valves. All parts of dismantling joints shall be amply proportioned to take care of all stresses that may occur during installation and in operation.

Dismantling joints shall have end, thrust and follower flanges and rubber sealing ring.

Tie rods shall be provided for rigid fixing after installation to enable transmission of thrust. Tie rods shall be provided for minimum 30% of the holes.

With the use of dismantling joints it shall be possible to have an approximate clearance of 25 mm with the adjoining fittings.

All dismantling joints shall be designed for a pressure of 16 bar.

Features of Construction

Outside of inner sleeve and inside of outer sleeve shall be machined to close tolerances. Inner sleeve end shall be chamfered for easy introduction of rubber ring.

Sleeves shall be of uniform bore and straight in axis. The flanges shall be square to the axis of sleeve. The faces of flanges shall be parallel. The bolt holes circle and outside periphery shall be concentric with the bore and bolt holes equally spaced. Bolt holes in one flange shall be located in line with those in other.

Bolt holes on flanges shall be drilled with the help of drilling jig.

Flanges shall be machined flat faced and shall be full or spot faced on the back side. Flange thickness shall be uniform throughout. Flange periphery also shall be finished smooth. Flanges shall be as per relevant applicable standard corresponding to design pressure. The flanges of dismantling joints mating with valves shall have drilling stranded matching with that of the valve.

Materials of Construction

(a) Body : CI IS: 210 Gr FG200

(b) Flanges : CI IS: 210 Gr FG200

(c) Sealing : EPDM Rubber

(d) Tie Rods, Bolts, Nuts and Washers : SS304

Design parameters

(a) Rating (bar) : 16

EXHAUST FANS

Fan should comply with IS 2312.

Fan blades shall be of mild steel / cast aluminum of an airfoil design mounted on stream lined hub. It shall be properly balanced so as to avoid noise and vibration. The blade and blade carriers shall be securely fixed so that they do not loosen in operation. Mild steel casing shall be of heavy gauge construction properly reinforced for rigidity. The means provided for securing the fan mounting or fan casing to the wall, partition such as to provide a secure fixing without damage to the fan or wall.

The fan shall have protective insulation or be capable of being earthed. A fan with protective insulation may be of all insulated construction or have either double insulation or reinforced insulation. The fan should be driven by single phase motor. Each fan should be provided with a wall cowl and bird screen. Bird screen shall be of 10mm square mesh and wall cowl shall be 18 G.

Fans shall be with ISI marking.

Description	Particulars
Capacity (cum/hr)	As required based on higher of heat load and air change requirements which shall be worked out by Contractor and shall be submitted to Engineer for approval.
Speed (rpm)	<1000 rpm
Location	Pump House Panel cum MCC Room

Bidder to note that above quantity does do not include small exhaust fans required in toilet. The costs of such fans are deemed to be included in civil cost.

PORTABLE EXTINGUISHERS

Portable extinguishers shall be of Carbon Dioxide type of 5 kg capacity. The extinguishers shall confirm to requirements of NFPA 12 and shall be UL/FM approved.

CHAIN PULLEYBLOCK

Manual hoists shall be complete with hand-chain, trolley, pulley block, hook, hand and load chains, brake and other accessories. They shall comply with the latest applicable standards, regulations and safety codes in the locality where equipment will be installed.

Each hoist shall be operated on a monorail (I-Beam) which will be supplied and

installed by the contractor. The factor of safety shall not be less than 5. The load chain may be heat-treated to give ductility, toughness and conforming to I.S. 3109/B.S. 1663/B.S. 3114. The load wheel is to be made from heavy duty malleable castings. The hand chain is to Conform with B.S. 6405:1984 and hand chain wheel may be made from pressed sheet steel with roller type guarding.

Gears shall be cut from solid cast or forged steel blanks or shall be stress-relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, Quality of Steel, heat treatment, face, pitch of teeth and design shall confirm to BS-436, BS-545 and BS-721. Spur and helical gears must comply with B.S. 436 and worm with B.S. 721.

Bearing must be ball and roller type conforming to I.S. 2513 / B.S. 2525-32:1954. Proper lubricating arrangements are to be provided for bearings and pinions. The brake for the lifting gear shall be automatic and always in action.

The proof testing of each chain pulley block is to be carried out as per latest applicable standards. The safe working load is to be marked in such way that is clearly visible from the operating level.

DESIGN BASIS FOR WASTE WATER COLLECTION SYSTEM

DESIGN BASIS

WASTEWATER COLLECTION SYSTEM

Rate of wastewater generation	85% of net water demand
Pipe Material	HDPE < 300mm GRP ≥ 300mm
Bedding	Granular/Concrete Encasement
Distance of Ordinary Manhole	At every 30 m
Peak Factor	As per CPHEEO
Depth of Cover	Minimum 1.2 m

PART- TECHNICAL SPECIFICATIONS WASTEWATER COLLECTION SYSTEM

GRP

Scope

This specification covers the requirements for manufacture, supplying, lowering, laying, jointing, testing and commissioning of Glass fiber Reinforced Plastic pipes and fittings (GRP) used for the conveyance of domestic sewage and industrial wastewater.

Standards

The manufacturing, testing, supplying, jointing and testing at work site of GRP pipes shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

I.S. 14402	Specification for glass fibre reinforced plastic (GRP) pipes, joint sand fittings, for the use for Sewerage, Industrial Waste and Water (other than potable)
I.S. 13916	Code of practice for Installation of glass fibre reinforced plastic (GRP) piping system
I.S. 5382	Rubber sealing rings for gas mains, water mains and sewers
I.S. 6746	Unsaturated, polyester resin systems for low pressure fibre reinforced plastic
I.S. 11320	Glass fibre rovings for the reinforcement of polyester and of epoxy deres in systems.
I.S.11273	Woven roving fabrics for "E" class fibre
I.S. 11551	Glass fibre chopped strand mat for the reinforcement of polyester resin system
I.S.12709	Glass fibre reinforced plastic (GRP) pipes, joints and fittings for use in potable water supply –Specification.
ASTMD 3262	Standard specification for "Fibre glass" (glass fibre reinforced thermosetting resin) sewerpipe.
ASTMD 4161	Standard specification for "Fibre glass" (glass fibre - reinforced thermosetting resin) pipe joints using flexible elastomeric seals.
ASTMD 2321	Standard practice for underground installation of Thermo plastic pipe for Sewers and Other Gravity Flow Applications
ASTMD 3839	Standard practice for Underground Installation of" Fibre glass"(glass fibre reinforced thermosetting resin)pipe

Design

Design of GRP pipes (Non Pressure pipes of stiffness classes B (124 kPa) and C (248 kPa) and pressure class PN3 (300 kPa) shall be in accordance with relevant clauses of

I.S. 14402.

Materials

Resin

An appropriate type of unsaturated polyester resin systems conforming to IS:6746 latest issue, shall be used. The tensile elongation at break shall be limited to a range of 0 to 25%. The limits for viscosity acid value, volatile content, gel time, etc shall be in accordance with IS: 6746.

Glass Fibre Reinforcement

Glass fibre reinforcement shall be of commercial grade E type and shall conform to IS 11273, IS 11320 or IS 11551, as appropriate.

Aggregate

Siliceous sand of a size range between 0.05 mm and 0.8 mm may be incorporated in the composite structure, in accordance with IS 14402.

Filler

Inert fillers with particle size below 0.05 mm may be incorporated either on their own or with aggregates, in accordance with IS 14402.

Additives

Additives may be incorporated to modify the resin properties.

Liner and Surface Layer

A liner or surface layer or both, when incorporated into or onto the pipe, shall meet with the structural requirements as per IS 14402.

Gaskets and Lubricant

The elastomeric gasket / ring used for jointing shall be as per the requirements of IS : 5382, latest issue. The gasket material shall be vulcanized solid rubber free from extractable substances which may impart odour or toxicity to the waste water. The ring shall be homogenous, free from porosity, grit, blooms, blisters or other visible imperfections.

The lubricant used for assembly of joints shall be inert so as to not damage the pipe and joint components. Lubricants other than those specified by manufacturer shall not be used without Engineer's approval.

Manufacturing

General

The method of manufacturing of GRP pipes shall be such that the form and the dimensions of the finished pipes are accurate and within the limits specified in relevant

clauses of IS: 14402. The surfaces and edges of the pipes shall be well defined and true and shall have squareness of pipe ends as specified in IS:14402.

The GRP pipes and joints shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality. The inside surface of each pipe shall not have any visible defects such as bulges, dents, ridges, foreign inclusion, cracks, crazing, pin holes and bubbles to the extent that it does not detrimentally affect the performance of the pipe. The workmanship shall be in accordance with IS 14402 and shall meet the acceptance criteria specified. No glass fibre reinforcement shall penetrate the interior surface of the pipe wall.

Joint sealing surfaces shall be free of dents, gauges and other surface irregularities that will affect the integrity of the joints.

Engineer shall at all reasonable times have free access to the place where the pipes and joints are manufactured for the purpose of examining and testing the pipes and joints and of witnessing the tests and manufacturing.

All tests, specified either in this specification, or in the relevant clauses of Indian Standards or International Standards shall be performed by Supplier/Contractor at his own cost and in presence of Engineer, if desired. For this, sufficient notice before testing of the pipes shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes of that lot. The decision of Engineer shall be final and binding on Contractor and not subject to any arbitration or appeal.

Dimensions and Tolerances

Pipes shall be designated by nominal standard diameters. The nominal diameters, minimum wall thicknesses, length of barrel, joints etc. shall be within the tolerance limits specified in IS: 14402. Pipes of pressure class PN3 (300 kPa), stiffness classes B (124 kPa) and C (248 kPa) with nominal diameters of 300 to 1200 mm and standard length of 6 m to 12 m are recommended. The wall thickness shall be such as to satisfy the inside and outside diameters as per IS: 14402 and the tests specified in IS: 14402.

Structural Properties

Stiffness

All GRP pipes used on this Contract shall be stiffness class B with minimum stiffness of 124 kPa at 5% deflection.

Longitudinal Strength

For sizes up to 600 mm, the pipe shall withstand without failure, the beam loads specified in IS 14402, when a 6 m effective length of pipe is tested as per IS 14402.

For pipe sizes larger than 600 mm, and alternatively for smaller sizes, adequate beam strength shall be demonstrated by tensile tests conducted in accordance with IS 14402 for pipe wall specimens oriented in the longitudinal direction.

Hoop Tensile Strength

The pipe shall meet or exceed the minimum hoop tensile strength as per relevant clauses of IS 14402, when a ring cut from pipe is tested by means of a split disc test in accordance with IS14402.

Hydraulic Properties

Soundness

Each length of pipe shall withstand without leakage or cracking the internal hydrostatic test pressures as per relevant clauses of IS 14402.

Long term hydrostatic design pressure test

The pressure class shall be based on long term hydrostatic design pressure data obtained in accordance with IS 12709 : 1994 and categorized in accordance with IS 12709 : 1994 and categorized in accordance with IS 14402. Pressure classes are based on extrapolated strength at 50 yrs.

Chemical requirements /tests

Chemical tests and other testing requirements shall be as per IS 14402.

Sampling and Testing

Lot

In any consignment all the pipes of same pressure and stiffness classes and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this specification shall be ascertained on the basis of tests on pipes selected from it.

Unless otherwise agreed upon between the purchaser and the supplier one lot shall consist of maximum of 100 pipes or part thereof, of each pressure class, stiffness class and size of pipe produced.

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order. Starting from any pipe, every 'r' the pipe be selected till the requisite number is obtained, 'r' being the integral part of N/n where 'N' is the lot size and 'n' is the sample size. The scale of sampling shall be as per following table.

Scale of Sampling

No. of pipes in the lot (N)	Sample Size for Dimensions, Work manship and Finish(n)	Sample size for Structural and Hydraulic properties (n)
Not more than 50	8	2
51 to 100	1 3	3

Each pipe shall be checked for dimensions, workmanship, and finish, deviation from straight, stiffness, beam strength, longitudinal tensile strength and hoop tensile strength. The lot shall be declared as conforming to the requirements of this specification, if the sample pipes taken from the lot meets the requirements of all the tests, otherwise not.

Testing of Pipes at the Factory

After selecting pipe specimens randomly from the lot as per clause above they shall be tested at the factory for the following:

Critical Dimensions

All pipes will be measured for compliance with dimensions as specified in relevant clauses of IS 14402 after allowing for the specified tolerances. The dimensions shall include inside and outside diameters, wall thickness, out-of-squareness and length. Pipes not in compliance will be rejected.

Visual Acceptance

The pipe shall be free from all defects, including delamination, bubbles, pinholes, cracks, pits, blisters, foreign inclusions and resin-starved areas that due to their nature, degree or extent, detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour, capacity, density and other physical properties. The workmanship shall be as per the acceptance criteria specified in Clause 9.1, Table 3 of IS14402.

Pipe Stiffness

Each length of pipe shall have sufficient strength to exhibit the minimum pipe stiffness as specified in clause 10.0 of IS 14402. The procedure should be as follows :

The apparatus shall consist of two parallel steel plates between which the test specimen is placed. A uniform vertical loading shall be applied to obtain 5% deflection and maintained for 2 minutes. The pipe stiffness is then calculated in accordance with the formula in Clause 10.1 of IS: 14402. The pipe shall exhibit the minimum pipe stiffness specified in Table 4 of IS 14402.

If a pipe sample from a lot fails to meet the required stiffness, a further two samples shall be tested from that lot. If they both pass, the lot will be accepted. If they fail, pipes will be tested on an individual basis and only pipes which pass will be accepted.

The pipe shall be further checked for percentage deflection levels X and Y as specified in Clause 10.1.1 of IS 14402 for ensuring that there is no visible damage evidenced by surface cracks at level X and no structural damage at level Y.

Hydrostatic Soundness Test

The manufacturer shall carry out the internal hydrostatic test pressure in accordance with the relevant Clauses 12.2 of IS 14402. The procedure should be as follows:

Each length of pipe, shall be placed in a hydrostatic pressure test machine which seals the ends and exert no end loads. The pipe shall be filled with water, expelling all air and an internal water pressure shall be applied at a uniform rate not to exceed 300 kPa/s until the test pressure of the pressure class is reached. This pressure shall be maintained for one minute. The pipe shall show no visual signs of weeping, leakage or fracture of the structural wall. Any pipes failing to pass this test will be rejected. Rejected pipes may be repaired and re-tested, if they pass, they will then be accepted.

Beam Strength Test

The manufacturer shall test the pipe for Beam strength as per the relevant clauses in IS 14402. The sample size shall be 6m in length. If any sample fails to withstand the requisite load as specified in the IS code, five (5) further samples should be taken and tested. If the results comply with requirement, all pipes will then be acceptable. However, if these five samples fail then all pipes from that lot will be rejected unless individually proven acceptable.

Longitudinal Tensile Strength

The manufacturer shall test the pipe for longitudinal tensile strength as per the relevant clauses on IS 14402. The test piece shall be strips cut from a pipe in the longitudinal direction as specified in IS 14402. If any sample fails to demonstrate the minimum requirement as specified in IS 14402, five other samples shall be tested. If the results comply with the IS code, all the pipes in the lot shall be accepted, otherwise the whole lot shall be rejected unless individually proven acceptable.

Hoop Tensile Strength

The manufacturer shall test the pipe for hoop tensile strength as per relevant clauses in IS 14402. The sample size shall be a minimum of 8mm width and shall not exceed the width of the split disc used for testing. Every sample piece should meet or exceed the hoop tensile strength specified in the IS code. If any sample fails to meet the requisite value five (5) further samples shall be taken and tested. If the results comply with requirement, all pipes will then be acceptable. However, if these five samples fail then all pipes from that lot will be rejected unless individually proven acceptable. Rejected pipes will, however, be acceptable for use at a lower working pressure as per the criteria stated in the specification.

Long Term Hydrostatic Design Pressure Test

The pressure classes shall be based on long term hydrostatic design pressure data obtained as per relevant clauses of IS 14402. For those products where no previous long term hydrostatic testing has been performed on similar products, the full type testing shall be carried out to define design pressure classes based on extrapolated strengths at 50 years. When a hydrostatic design basis has already been established for a nominally similar pipe using the same manufacturing process, the manufacturer need only conduct the re-qualification test as described in the relevant clauses of IS14402.

Test Certificate for Chemical Resistance of GRP Pipes in a Deflected Condition

The contractor shall produce a test certificate for chemical resistance of GRP pipes in a deflected condition that when installed within 5% deflection the pipes will last over 50 years under highly acidic and corrosive conditions and stand guarantee for the same. The pipe shall be tested for chemical resistance as per clause 16.0, IS 14402 and shall be capable of being deflected, without failing at the 50 years strain level specified in IS 14402, when exposed to 1.0 N Sulphuric Acid.

Marking

Both ends of each length of pipe and fitting shall be marked in bold letters not less than 12 mm in height and of bold type style in a colour and type that remains legible under normal handling and installation procedures. The marking shall include the following:

- a) Nominal pipe diameter
- b) Class of pipe (pressure & stiffness)
- c) Date of manufacture
- d) Name of manufacturer or his registered trade mark or both.
- e) Name of employer

Pipe may also be marked with BIS Certification marking.

Handling

The Contractor shall be responsible for safe delivery of pipes and fittings as per order placed and as per the schedule. The Contractor shall submit a complete manual of instructions/ guide/procedure for handling of pipe before installation. Broadly the following instructions/procedures shall be followed.

Transportation

All pipe sections shall be supported on flat timbers spaced on a maximum of 4 meters centres with a maximum overhang of 2 meters in trucks. No pipes shall be in contact with other pipes while transportation, so that vibrations during transport will not cause abrasion.

Maximum stack height will be approximately 2.0 meters. Pipes shall be strapped to the vehicle over the support points using pliable non-metallic straps or ropes. Steel cables or chains shall not be allowed for strapping without adequate padding.

Storage

Pipes of diameter less than 1 m may be directly stored on sandy soil while pipes with diameter greater than 1 m shall be stored on their delivery cradles or on flat timbers. When storing on ground the ground shall be flattened and made free of potentially damaging debris. All pipes shall be chocked to prevent rolling.

If it is necessary to stack pipes, flat timber supports at maximum 6 meter spacing with chocks shall be used. If it is available, the original shipping dunnage shall be used. The stacks shall be stable against wind or other horizontal forces. Maximum stack height allowable shall be approximately 2 metres.

Rubber gasket rings shall be shipped separately from the couplings and shall be stored in the shade in their original packaging and shall not be exposed to sunlight except during pipe jointing. The gaskets shall also be protected from exposure to greases and oils and from solvents and other deleterious substances.

Gasket lubricant shall be carefully stored to prevent damage to the container. Partially used buckets shall be resealed to prevent contamination of the lubricant.

Unloading, Lifting and Lowering

The specifications as per IS 13916, Clause 4.3 shall be followed.

Adequate control shall be ensured during unloading and lifting of pipes with guide ropes attached to pipes or packages. Spreader bars shall be used when multiple locations are necessary. The pipes shall not be dropped to avoid impact or bump, particularly at pipe ends.

Non-unitised stack of pipes shall not be handled as a single bundle. Non-unitised pipes shall be handled separately, one at a time. Pipes shall be handled or lifted with pliable straps, slings or ropes. Steel cables or ropes shall not be used for lifting and transportation of pipe. Ropes shall not pass through the section of pipe, end to end.

If any time during handling or installation of pipe, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired or replaced as directed by Engineer before installation.

Jointing

Pipes shall be joined together using either Double Socket Couplings or Double O-Ring spigot and socket joints which shall be in accordance with the relevant clauses of IS 13916 or ASTM D4161 as indicated in the following paragraphs. The joints shall be axially unrestrained joints, using rubber rings or gaskets. The rings or gaskets used for jointing shall conform to the requirements of IS 5382.

Joint Requirements

Joint Surfaces

All surfaces of the joint upon or against which the gasket may bear, shall be smooth and free of cracks, fractures or other imperfections that could adversely affect the joint performance.

Joint Geometry

The design of the joint shall be such that it prevents unintentional displacement of the gasket during joint assembly or operation of completed piping system.

Dimensions and Tolerances

The shape and dimension of the gasket and annular space provided for it, volume of annular space, design volume of the gasket, the deformation experienced by gasket

upon jointing, and the circumferential compression / tension of gasket upon placing in socket / over spigot shall be as specified in Clause 6 of ASTM D4161. The manufacturer shall submit details (supported by drawings) of joint geometry, tolerances, gasket characteristics, proposed plant tests and other information as required by Engineer, so as to evaluate the joint design for field performance.

Joint Testing

Hydrostatic Pressure Test

The pipe joints shall be tested by manufacturer, for joint tightness, in both angularly deflected as well as laterally offset positions, in accordance with Clause 7 of ASTM D4161. The internal hydrostatic test pressure to be applied while testing, should be two times the rated pressure of the pipe (i.e. 600 kPa in the case of Class PN3 pipe). There should be no leakage or damage of joint components when the test pressure is applied for a period of 10 minutes.

Vacuum or External Pressure Test

The pipe joint assembly shall withstand an external pressure of 80 kPa or an internal vacuum of -80 kPa, in both angularly deflected and laterally offset positions, when tested in accordance with Clause 7 of ASTM D4161.

Joint Assembly

The joints shall be assembled in accordance with the relevant clauses of IS 13916 and the manufacturer's instructions.

Lay-up Joints / Rigid Connections

When pipes are connected to rigid structures (such as manholes or inlet chambers of pumping stations / treatment plants), provision shall be made for differential settlement that might occur between the pipeline and the structure. This shall be done using short connector pipes with a rubber or bitumen wrap around the portion penetrating the concrete. Alternatively, a coupling joint cast into the concrete – pipe interface, may be used.

The contractor shall provide full details of the lay-up joints and polymer resin, which will be used for connection of pipes to manholes and other rigid structures.

Joining Pipes With Different Wall Thicknesses

When two pipes of same diameter but of different wall thicknesses are required to be joined at site, the contractor is required to execute the joint very precisely so as to have straight alignment of pipe inverts.

Field Hydro testing For Water Tightness

Completed pipeline inclusive of manholes shall be hydrostatically tested for water tightness prior to acceptance and service. It shall be done regularly as installation

proceeds.

After the joints have been checked by Engineer and before backfilling the trenches, the entire section of laid pipeline shall be tested for water tightness by filling in pipes with water to the level of 1.5 m above the top of the highest pipe in the stretch. The heading of water shall be retained for 1.0 hour. If any leakage is detected it shall be repaired and re-tested for no leak. If required by Engineer, the contractor shall de-water the excavated pit/trench and keep it dry during the period of testing.

All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipeline shall be arranged by contractor. Damage during testing shall be contractor's responsibility and shall be rectified by him to the full satisfaction of Engineer. Water used for the test shall be removed from the pipes and not released to the excavated trenches.

Concrete Encasement

When encasement of pipes in concrete has been specified to carry unusual loads, specific limitations in the installation procedures shall be observed.

The concrete surround must be placed in stages allowing sufficient time layers for the cement to set (no longer exert buoyant forces). Maximum lift height is variable with nominal pipe stiffness as shown below :

62 kPa and 124 kPa Not more than 300 mm or D/4, whichever is larger 248kPa Not more than 450 mm or D/3, whichever is larger 496kPa Not more than 600 mm or D/2, whichever is larger. Where D = Pipe Diameter

Cutting of Pipes

When the pipe is cut, the exposed ends shall be sealed with approved resin as specified in Clause 7.4.1 of this specification. When such cutting and sealing takes place at site, the method of storage, mixing, application and curing of the resin shall be strictly as per manufacturer's recommendation. Before any such work takes place the manufacturer's representative shall visit the site to demonstrate and give clear procedural advice to the Contractor, in the presence of the Engineer.

Joint Tightness at Field

The maximum angular deflection between the longitudinal axes of any two jointed pipes should not exceed the values specified below, after installation, in order to ensure joint tightness.

Pipe Nominal diameter (mm)	Maximum Allowable Angular Deflection at Joint
≤500	3°
> 500, up to 900	2°

The maximum angular deflection for which the manufacturer declares the joint to be suitable, shall not be less than the values stated above.

Bedding

The type of bedding for the GRP pipes (granular, concrete cradle – PCC, RCC, concrete encasement, etc.) shall be as per relevant IS Codes.

Granular Bedding

Where pipes are laid with a granular bed or surround the appropriate bedding material shall, as soon as a section of trench has been trimmed to grade, be placed carefully over the full trench width without segregation. The material shall be spread and thoroughly compacted by approved mechanical means in successive uniform layers each not exceeding 150mm compacted thickness to produce a uniform bed to the required gradient. Where plate vibrators are used, there shall be a minimum of one pass for crushed stone and two passes for sands. Hand tamping will only be permitted where insufficient space is available to allow the use of mechanical plant. The minimum thickness of compacted granular material shall be as follows:-

- (i) 150mm (minimum 100mm under sockets) for pipes not exceeding 300mm nominal diameter, except when trench is in rock.
- (ii) 200mm (minimum 100mm under sockets) for pipes greater than 300mm nominal diameter, or all pipes when trench is in rock.

The pipes shall then be set evenly on the bed, great care being taken to ensure uniform support for the entire length of the pipe.

Pockets in the bedding shall be formed at each pipe joint to permit jointing to be carried out without the sleeve or socket of the pipe joint bearing on the bedding material and without bedding material entering the joint.

After the pipeline alignment and joints have been inspected and approved by the Engineer, the water testing of the pipeline satisfactorily completed, and, where appropriate, the annular gap at each pipe joint sealed, each joint pocket shall be carefully filled with granular material and thoroughly compacted up to the same level as the top of the bedding. Granular bedding material of the same type shall be placed on both sides of the pipeline in successive uniform layers not exceeding 150mm thick and compacted according to the methods as given in this specification, and/or as agreed with or directed by the Engineer. Care shall be taken to ensure that no cavities remain under the pipe, and that the pipes are not displaced by differential pressure from either side.

When placing and compacting surround material the Contractor shall take care not to displace or damage the pipes. The tipping of surround material from ground levels directly onto the pipes shall not be permitted.

<u>Granular Surround - Compaction Requirements</u> Surround Material	Max. Layer Thickness	Alternative Methods (Number of Passes of (Compaction Plant)		
		Hand Rammer	Vibrating Plate	100kg power Rammer*
Crushed Aggregate Sand	150	2	1	2
	75	3	2	4

Special Foundation in Poor Soil

Where the formation of the trench is found to consist of material which is unstable to such a degree that in the opinion of the Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings to be prepared by the Contractor and as instructed by Engineer shall be constructed.

Inspection of Pipelines

As soon as the pipeline has been completed from manhole to manhole the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall make good the pipeline and carry out such further tests as are ordered by the Engineer.

Site Testing

After laying and jointing of pipes is completed the pipe line shall be tested. All equipment for testing shall be supplied by the Contractor. Damage during testing shall be contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer. Water for testing of pipeline shall be arranged by the Contractor at his own cost.

After the joints have been checked by the Engineer and before backfilling of the trenches, the entire section of the sewer shall be proved by the contractor to be watertight by filling the pipes with water to the level of 1.50m above the top of the highest pipe in the stretch and heading the water up for a period of one hour. The apparatus used for the purpose of testing shall be approved by Engineer. The Contractor if required

by the Engineer shall de-water the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes shall be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For acceptance of the section of pipeline under test the average quantity added shall not exceed 1 litre/ hour/100 linear metres / 10mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level in excess of the permitted amount will result in the pipeline being rejected. The Contractor will be required to remove and re-lay the pipeline for re-testing.

HIGH DENSITY POLYETHYLENEPIPES

Scope

This specification covers the requirements for manufacture, supplying, lowering, laying, jointing, testing and commissioning of High Density Polyethylene pipes (HDPE) and fittings used for the conveyance of domestic sewage/waste water.

Standards

The manufacturing, testing, supplying, laying, jointing and testing and commissioning of HDPE pipes and shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

- | | |
|-------------------|--|
| I.S. 14333 | Specification for High Density Polyethylene pipes (HDPE)andfittings, for the use forSewerage. |
| I.S. 7634(Part-2) | Code of practice for Laying and Jointing of High Density Polyethylene pipes (HDPE) piping system |
| I.S. 2530 | Method of test for polyethylene moulding materials and polyethylenecompounds, |
| I.S. 7328 | High Density Polyethylene material for moulding andextrusion. |
| I.S. 4905 | Method for randomsampling. |

Design

Design of HDPE pipes including material details and the maximum allowable hydrostatic design stress taking in to consideration the temperature and design life of pipes shall be in accordance with the relevant clauses of IS:14333 : 2000.

Contractor shall submit for approval complete details regarding the Type, Material, Pressure rating, Methodology of jointing laying of HDPE pipes during design stage.

Grade of Material

The High Density Polyethylene Pipes (HDPE) are available in the range of 63 mm to 1000 mm nominal diameter of pressure rating 0.25 MPa to 1.60 MPa on material grades of PE 63, PE 80 and PE 100 for sewerage applications.

Material Grade, Minimum Required Strength and Maximum Allowable Hydrostatic Design Stress is specified in the relevant clause of IS – 14333:2000.

Manufacturing

General

The method of manufacture of HDPE pipes shall be such that the internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with axis of the pipes. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided that the wall thickness remains within the permissible limits.

The Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and of witnessing the test and manufacturing.

All tests specified either in this Engineer's Requirements or in the relevant Indian standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if he so desires. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes of that lot.

Materials

High Density Polyethylene

High density polyethylene used for the manufacturer of pipes shall confirm to designation PEEWA – 45 – T – 006. The minimum required strength of material should not be lower than 6.30 MPa at 20 deg. Centigrade at 50 years. The Melt Flow rate (MFR) of the material shall also be within +/- 20% of the value declared by the manufacturer. The resin shall be compounded with carbon black and tested according to the procedure described in IS 2530:1996.

Anti-Oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin.

Jointing

Fusion Welding

Fusion welding shall be used for jointing of HDPE pipe to pipe. The pipe should be cut square and the face of the pipe should be slightly scraped prior to welding to remove oxidised layer. At the time of welding, levelling of the pipes is essential particularly in case of larger diameter pipes. Welding temperature should be 200 Deg. Centigrade and surface of heating mirror should be 210 +/- 5 deg. Centigrade (heating mirror is a metallic plate heated up to the required temperature either by electrical coil embedded inside or by blow torch). The welding of the pipe should be held in either side of the heating mirror and immediately the joint is made by application of moderate pressure of approximately 1 to 2 Kg/Sqcm for 2 to 3 seconds. The initial heating time for achieving moltenrim, varies from 1to5 minutes depending upon the pipe wall thickness and size.

Following precautions shall be taken while fusion welding

- a. It is essential to see that the rim formed is not excessive.
- b. While jointing, the pressure should be maintained until the joint is lukewarm and after the pressure is relieved, the joint allowed to cool completely.
- c. The mirror should be kept exactly around 210 deg. Centigrade which needs about 30 min. time (for electrical mirror). It is also essential to see that the temperature is maintained constant by the proper setting of regulator. For detecting the correct temperature, crayon chalk is used. For example at 210 deg. Centigrade the colour of crayon dot on the mirror changes within 2 seconds. But the dot made should be thin and if not, time taken will be more, indicating a wrong temperature.

A satisfactory but welded joint of HDPE will have the strength factor of one. Temperature is of primary importance and weld efficiency may decrease if the temperature is more or less than 210 deg. Centigrade.

Flanged Joints:

Jointing of PE Pipes with fittings, valves, metal pipes, and where non-PE pipes are to be joined with PE pipes shall be carried out using Flanged joints. Flanges will be used to fit together elements of different materials such as valves (in cast or ductile iron) with HDPE pipes through the use of a flange adaptor.

The joining consists of slip-on metallic/polyethylene flanges with collar/stub ends. The Collar/stub-end shall be welded either by butt, socket or electro fusion - as per the latest Indian Standard or any International Standard along with the procedure mentioned in the previous sections (*as guidelines*) to the pipe, valves and fittings.

The nominal pressure rating shall be at least equal to the highest pressure rating of the pipes or fittings to which they are attached, but with a minimum PN 10.

Gaskets for Flanged Joints

Gaskets for flanged pipe joints shall be of the inside bolt circle type and the dimensions shall comply with BSEN 1514-2:2005 – Flanges and their joints. Dimensions of gaskets for PN-designated flanges. Spiral wound gaskets for use with steel flanges.

The physical properties of gaskets shall comply with BS 7874:1998 (Method of test for microbiological deterioration of elastomeric seals for joints in pipework and pipelines for effects on water quality and resistance to microbiological deterioration). The Gaskets shall also comply with the relevant provisions in BS 7874:1998 for effects on water quality and resistance to microbiological deterioration. The Gasket material shall be EPDM/SBR and shall be of average hardness of 65-75.

The Gaskets shall be supplied by the manufacturer and shall suit for PN 10 flanges unless otherwise stated. Each gasket shall be marked clearly and durably in accordance with the following information in a manner that does not interfere with the sealing function of the gasket, in complying with clause 10 of EN 681-1:1996.

- a). The nominal size
- b). Manufacturer identification
- c). The number of the BS or BSEN with seal type designation.
- d). Abbreviation for the elastomer

Carting & Handling

Method statements shall be submitted by the Contractor for the approval of the Engineer before the handling, transportation and laying of any pipes commences. All pipes shall be handled and stored in compliance with the manufacturer's recommendations. Pipes and fittings /specials shall be transported from the factory to the central pipe store and unloaded there before being transported to Site. At every point of loading or unloading, all pipes and fittings shall be lifted using approved lifting tackle. Unloading by rolling down any form of inclined ramp will not be permitted. Pliable straps or slings shall be used to lift pipes. Rope, wire rope, hooks or chains shall not be allowed to come into contact with any pipe surface. All pipes shall be thoroughly inspected on arrival on site and immediately prior to installation. Any damage to the pipes shall be notified to the Engineer for a decision as to the acceptability of the pipes, with or without repairs or remedial work. The final judgement will be taken by the Engineer based on his judgement of the suitability of the items for the purpose intended.

Reworked Material

The addition of not more than 10% of the manufacturer's own rework material resulting from the manufacturer of pipes of this standard is permissible. No other reworked or recycled material shall be used.

Dimensions and Tolerances

The outside diameters of pipes, tolerance on the same and ovality of pipes shall be as given in relevant clause of I.S. 14333: 2000. No negative tolerances are allowed.

The minimum and maximum wall thickness of pipes shall be as given in relevant clause of I.S. 14333: 2000.

The length of straight pipe shall be 5 m to 20 m, as agreed between the manufacturer and purchaser. Short lengths of 3 m (minimum) up to maximum of 10% of the total supply may be permitted.

The pipes supplied in coils shall be coiled on drums of minimum diameter of the pipe ensuring that kinking of pipe is prevented.

Workmanship and Finish

The internal and external surfaces of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with the axis of the pipes.

Slightly shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided that the wall thickness remains within the permissible limits. The colour of the pipe shall be black.

Testing

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 2530 and tests in accordance with the methods described in relevant clause of I.S.:14333.

- i) Hydrostatic test
- ii) Reversion test
- iii) Density test
- iv) Melt Flow Rate
- v) Carbon Black Content and Dispersion

Storing, Handling and Hauling of Pipes, Fittings and Specials General Principles

The recommendations for handling and storage of PE pipes shall have greater care in the handling of PE 100 pipe coils too shall have greater care as of pipes of similar wall thickness. Polyethylene is a tough resilient material which is relatively light and easy to handle although it is prone to damage through scoring by sharp objects. Therefore careful handling is always required and the dragging of straight pipe and coils shall be avoided.

The maximum allowable depth of scoring of the external surface of the pipe is 5% of the wall thickness. Pipes and fittings showing obvious defects or excessive scoring shall be withdrawn, clearly identified as unsuitable and, where appropriate, returned to the source of supply. The general properties of polyethylene are unaffected by low ambient temperatures but, having very smooth surfaces, the pipes and fittings become slippery in wet or frosty weather. Particular attention shall be given to effective securing and storage under such conditions.

Extra care shall also be taken when handling large diameter prefabricated fittings during very cold weather.

The packaging of pipes by the manufacturer is normally consistent with the requirement to prevent damage and to comply with safety considerations. Usually pipes are delivered strapped into convenient bundles or banded coils. Fittings are normally supplied in

separate cartons together with any associated small items, such as bolts and gaskets.

As far as practicable the protective packaging (pallets, strapping, bags etc.) shall be kept intact until the material is required for use. The temporary capping or plugging of pipe ends is recommended.

Pipes and fittings likely to be stored outside for periods longer than 12 months shall be covered by a tarpaulin or black polyethylene sheeting to prevent ultra violet degradation from sunlight. Electro fusion fittings shall be stored under cover and in their protective packaging.

For hygiene purposes, the pipe ends must be protected from the ingress of dirt/water etc. This protection shall be carefully disposed of following use.

Protection during Delivery

The Contractor shall provide methodology of protection of pipes and fittings, to the approval of the Engineer and obtain written approval prior to the pipes and fittings leaving the place of manufacture and shall maintain such protection until the items reach their destination in order to guard effectively against damage during handling, transit and storage and ingress of foreign matter inside the pipes & fittings. All fittings shall be securely packed in crates and boxes to prevent damage during delivery. The cost of packing shall be deemed to be included in the Contract Rates and crates will not be returned. The Supplier shall provide necessary details to the shipping line on precautions to be taken during loading/unloading, handling & transport of the pipes & fittings and other components, in the sea. Supplier shall provide to the purchaser a set of recommendations of manufacturer for handling, loading, unloading, transporting and storing of polyethylene pipes and fittings.

Transport and Delivery

When transporting straight polyethylene pipes, use flat bedded vehicles. The bed shall be free from nails and other projections. The polyethylene pipes shall rest uniformly in the vehicle over their long length. The vehicle shall have side supports approximately spaced 2 m apart, and the pipes shall be secured effectively during the transportation. All posts shall be flat with no sharp edges. Strapping the pipe bundles during transit may be required to avoid excessive movement in the truck. PE pipes shall not be transported with other metallic items in the same vehicle. Coiled pipe with OD 63 mm shall be supplied individually. There shall be facilities to ensure each coil is securely fastened throughout transit and the un-loading process. To save on transport cost nesting of coils/straight length can be considered if agreed between the purchaser and the supplier.

Off Loading

Bundled Pipes

When lifting by crane, non metallic wide band slings or ropes shall be used, and for pipe lengths greater than 6m, load spreading beams of a length at least equivalent to one quarter of the length of the pipe or bundle pack shall be employed. Chains or end hooks

shall not be used. Care shall be taken to avoid damage to pipes and pipe ends during lifting, particularly those pipes with couplers. Some bending shall be allowed for in the middle of the lift when loading and unloading pipes and, because of this, lifting points shall always be well spread and evenly spaced. Standard bundle packs, 6m long, may be handled by fork lift trucks but due allowance shall be made for the flexible nature of the pipes in the positioning of the forks and the raising of the load. Bundle packs greater than 6m long shall be handled either by a side loader with a minimum of four supporting forks, or by a crane using a spreader beam and suitable slings. Individual pipes may be and led in the same way. Off-loading on site may be made easier by using skid timbers and rope slings.

Coiled Pipes

Pipe coils shall be transported inside containers from place of manufacture. Manufacturer/Tenderer (Contractor) shall ensure that coils of pipes are not exposed to direct sunlight at any place, during transit. Tenderer (Contractor) shall deliver the pipe containers in closed condition to purchaser's stores as directed and only inside the purchaser's warehouse, the containers shall be opened for inspection. Tenderer in coordination with the purchaser shall make arrangements for customs clearance, when the containers are brought to storage warehouse. Reinforced adhesive tape at least 50 mm wide shall be used for banding. Complete coils are secured by outer and intermediate bands and individual layers are also independently secured. These shall not be removed until the pipe is required for actual use. Before unstrapping pipe from the coil or drum, both pipe ends must be firmly mechanically restrained. The band securing the outer end of the pipe shall be removed first and the movement of the free end carefully controlled. This removal shall be followed with those securing successive layers. No more bands shall be removed than necessary to release the length of pipe immediately required. After sufficient pipe has been cut from the coil the protective end cap must be replaced on the remainder. The outer end of the pipe shall be suitably re-marked as such. When removed from the coil or drum, the pipe will be oval and curved. The extent of ovality and curvature will depend upon the temperature, SDR rating, pipe diameter, coil diameter and material type. Although both ovality and curvature will reduce naturally with time, special hardware is available to facilitate handling and jointing.

Storage at Depot

Materials of different polymer manufacture should be kept separately and clearly identified.

Blue polyethylene pipe should preferably be stored under cover and protected from direct sunlight until required for use. Where storage facilities necessitate the material to be exposed externally, suitable good protective sheeting should be used.

All pipe stacks should be made on sufficiently firm, leveled ground and free from stone to support the weight of the pipes and any necessary lifting equipment. Stacking heights should be kept to a minimum and without exceeding the manufacturer's recommendation and adequate space allocated for lifting machinery to manoeuvre (more carefully and often with difficulty) without causing accidental damage.

For safety and the convenience of handling, the stacking height for bundles should not

be more than 3 metres. To prevent possible deformation of the pipes, bundles must be stored timber to timber. The Bidder shall make arrangements to stack wrapped/bagged coils neatly on robust pallets (free from projections), in Central Stores, conforming to the following maximum stack heights.

- 1 coils for 110 mm diameter pipe
- 1 coils for 125 mm diameter pipe
- 1 coils for 180 mm diameter pipe

Forklift trucks shall not be used to load and unload pipes except where coils are neatly stacked on pallets or coils and are provided with slings. For similar reasons, pipe coils should be stored flat and the number of coils per stack should be limited to; Where individual pipe lengths are stacked in pyramidal fashion, deformation may occur in the lower layers, particularly in warm weather. Such stacks should therefore be no more than 1 metre high. Socketed pipes should be stacked with the sockets at alternate ends and with the sockets protruding to avoid uneven stacking which may permanently distort the pipes. Polyethylene fittings should be stored under cover, preferably on racking and in the manufacturer's protective wrapping or cartons which should be kept intact until the fitting is required for use.

At all times pipes and fittings should be stored away from exhaust outlets and all other high temperature sources. Care should also be taken to avoid contact with lubricating or hydraulic oils, gasoline, solvents and other aggressive chemicals. All special tools and equipment associated with the jointing of PE pipes and fittings should be stored separately and securely until they are required for use. The heating faces of fusion tools should be kept in a position where the surfaces are protected from scratching or other damage. Tools incorporating cutting edges should likewise be protected from damage that could cause poor joint preparation.

Pipeline Construction

General

Pipes shall be laid and jointed in accordance with all relevant recommendations of the manufacturer. Any variations between the manufacturer's recommendations and this Specification shall be highlighted in the Contractor's Method Statements and a ruling will be given with the approval. All pipe laying shall be performed by experienced and competent pipe layers.

The line of the pipe shall be set out and agreed and drawings submitted for approval before commencement of the excavation. Surface stripping, excavation, pipelaying, backfilling and reinstatement shall follow each other without undue delay or interval between these activities.

Laying of Pipes

Boning Staves and Sight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all

intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by Engineer.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of metres and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of the tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of the pipe etc. as the case maybe.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the centre lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.

The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and Engineer gives permission to proceed with the backfilling.

Laying of Pipes and Fittings/Specials

The joints and interiors of all pipes and fittings shall be carefully cleaned before installation. Whenever pipe laying is interrupted for any reason, the open end of the pipeline shall be sealed with a suitable expanding stopper or a properly fitted temporary wooden stopper and exposed pipes shall be suitably protected from stones and other objects falling into the trench from above.

The permissible tolerance for pipelines in trenches shall be 6mm in level and 25mm in line between manholes. After the laying of a length of a pipeline but before testing the crown of the pipe shall be checked for level and alignment and any necessary adjustment made by unjointing and removing the pipes concerned, adjusting the bedding, relaying the pipes and rechecking for line and level. In addition, where a gravity pipeline is shown on the Drawings as being straight between manholes it will not be accepted unless a light can be sighted directly through the length concerned.

While installing the pipe in trenches, the bed of the trench should be level and free from sharp edges stones. While laying in rocky areas suitable bed of sand or gravel should be

provided. The initial backfill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete M-100, 15 cm thick may be provided, before putting in the soft sand / gravel.

Bedding

The type of bedding for the HDPE pipes (sand bedding, granular bedding, etc.) shall be as per specifications below.

Granular Bedding

Where pipes are laid with a granular bed or surround the appropriate bedding material shall, as soon as a section of trench has been trimmed to grade, be placed carefully over the full trench width without segregation. The material shall be spread and thoroughly compacted by approved mechanical means in successive uniform layers each not exceeding 150mm compacted thickness to produce a uniform bed to the required gradient. Where plate vibrators are used, there shall be a minimum of one pass for crushed stone and two passes for sands. Hand tamping will only be permitted where insufficient space is available to allow the use of mechanical plant. The minimum thickness of compacted granular material shall be as follows:-

- (i) 150mm (minimum 100mm under sockets) for pipes not exceeding 300mm nominal diameter, except when trench is inrock.
- (ii) 200mm (minimum 100mm under sockets) for pipes greater than 300mm nominal diameter, or all pipes when trench is inrock.

The pipes shall then be set evenly on the bed, great care being taken to ensure uniform support for the entire length of the pipe.

Pockets in the bedding shall be formed at each pipe joint to permit jointing to be carried out without the sleeve or socket of the pipe joint bearing on the bedding material and without bedding material entering the joint.

After the pipeline alignment and joints have been inspected and approved by the Engineer, the water testing of the pipeline satisfactorily completed, and, where appropriate, the annular gap at each pipe joint sealed, each joint pocket shall be carefully filled with granular material and thoroughly compacted up to the same level as the top of the bedding. Granular bedding material of the same type shall be placed on both sides of the pipeline in successive uniform layers not exceeding 150mm thick and compacted according to one of the methods given in Table below as agreed with or directed by the Engineer. Care shall be taken to ensure that no cavities remain under the pipe, and that the pipes are not displaced by differential pressure from either side.

When placing and compacting surround material the Contractor shall take care not to displace or damage the pipes. The tipping of surround material from ground levels directly onto the pipes shall not be permitted.

Table. Granular Surround - Compaction Requirements

Surround Material	Max. Layer Thickness mm	Alternative Methods (Number of Passes of Compaction Plant)		
		Hand Rammer	Vibrating Plate	100kg power Rammer*
Crushed Aggregate Sand	150	2	1	2
	75	3	2	4

* not to be used above springing level

For pipes with a full granular surround the granular material shall extend up to a minimum height of 300mm over the crown of the pipes. For rigid pipes unless otherwise detailed, the granular material shall extend up to the springing level of the pipe. The surround shall be completed by the careful placing of selected excavated material in layers not exceeding 150mm thick, thoroughly compacted on both sides of the pipeline to a level at least 300mm above the crown of the pipes.

If the Contractor wishes to use any other method of laying pipes in granular bedding or surround he must submit his proposals in writing to and obtain the approval in writing from the Engineer well in advance of the date when he wishes to perform the work.

Inspection of Pipelines

As soon as the pipeline has been completed from manhole to manhole the Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall make good the pipeline and carry out such further tests as are ordered by the Engineer.

Site Testing

After laying and jointing of HDPE pipes is completed the pipe line shall be tested. All equipment, material, and labour for testing shall be supplied by the Contractor. Damage during testing shall be contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer. Water for testing of pipeline shall be arranged by the Contractor at his own cost.

After the joints have been checked by the Engineer and before backfilling of the trenches, the entire section of the sewer shall be proved by the contractor to be watertight. Water used for the test shall be removed from pipes and not discharged to the excavated trenches.

The Contractor shall carry out final testing of the equipment and commissioning of all pipelines to the satisfaction of the Engineer.

TREATED WATER CHARACTERISTICS

PARAMETER	CPHEEO Standards	Desired Standards
TURBIDITY (NTU)	1	< 1
COLOUR (Hz)	5	5
TASTE	Agreeable	Agreeable
ODOUR	Agreeable	Agreeable
pH	7-8.5	6.5-8.5
TOTAL DISSOLVED SOLIDS (mg/l)	500	500
TOTAL HARDNESS (as CaCO ₃) (mg/l)	200	200
CHLORIDE (mg/l)	200	200
SULPHATE (mg/l)	200	200
FLUORIDE (mg/l)	1	0.7-1.0
NITRATE (mg/l)	45	45
CALCIUM (mg/l)	75	75
MAGNESIUM (mg/l)	30	30
IRON (mg/l)	0.1	0.1
MANGANESE (mg/l)	0.05	0.05
COPPER (mg/l)	0.05	0.03
ALUMINIUM (mg/l)	0.03	0.03
ALKALINITY (mg/l)	200	200

PARAMETER	CPHEEO Standards	Desired Standards
RESIDUAL CHLORINE (mg/l)	0.2	0.2
ZINC (as Zn) (mg/l)	5	3
MERCURY (as Hg) (mg/l)	0.001	0.001
Coliform Count MPN/100 ml	Absent	Absent
Faecal coliforms MPN/100 ml	Absent	Absent

TREATED WASTEWATER CHARACTERISTICS FOR HVAC MAKEUP PURPOSE

Sr. No.	Parameter	Unit	Value
1	pH	-	6.8 - 7
2	BOD ₅	mg/l	<10
3	COD	mg/l	<50
4	Total Suspended Solids	mg/l	<5
5	TDS	mg/l	< 250
6	Oil and Grease	mg/l	<10
7	Total Nitrogen	mg/l	<10
8	Chlorides mg/l	mg/l	< 50
9	Alkalinity mg/l	mg/l	< 80
10	Hardness mg/l	mg/l	< 50
11	Total Phosphorus	mg/l	< 2
12	Reisdual chlorine	mg/l	< 1
13	Silica	mg/l	<30
13	Bio – Assay Test	mg/l	90% survival of fish after 96 hrs. in 100% effluent