



CHENNAI METROPOLITAN WATER SUPPLY & SEWERAGE BOARD



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**JICA FUNDED PROJECT
BIDDING DOCUMENT**

FOR

**PROJECT FOR CONSTRUCTION OF CHENNAI
SEAWATER DESALINATION PLANT (I)**

**PART-II (VOLUME 4 OF 5)
(EMPLOYER'S REQUIREMENTS)**

**PROCUREMENT OF DESIGN/ENGINEERING, CONSTRUCTION, COMMISSIONING OF
400 MLD SEAWATER REVERSE OSMOSIS (SWRO) DESALINATION PLANT AT PERUR,
CHENNAI WITH 20 YEARS OF OPERATION AND MAINTENANCE (DBO BASIS)**

INTERNATIONAL COMPETITIVE BIDDING

PROJECT MANAGEMENT CONSULTANTS

SMEC International Pty Ltd.
NJS Engineers India Pvt. Ltd.
Tata Consulting Engineers Ltd.
SMEC India Pvt. Ltd.

SUPERINTENDING ENGINEER

**(CONTRACTS & MONITORING)
CHENNAI METROPOLITAN WATER
SUPPLY & SEWERAGE BOARD**

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PART II EMPLOYER'S REQUIREMENTS

Section VI-5A-Technical Specifications

GENERAL SPECIFICATIONS FOR CIVIL WORKS

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5A.1 - SITE CLEARANCE (CLEARING AND GRUBBING)

5A.1.1. Scope

This work shall consist of site cleaning by Manual resources and by Mechanical equipment ,for cutting, removing and disposing or stacking at the approved place by the contractor for all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc., from the area of Works which in the opinion of the Employer's Representative are unsuitable for incorporation in the Works, and such other areas as may be specified on the Drawings or by the Employer's Representative. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed before Earthwork operations and in accordance with the requirements of these Specifications, All works shall be priorly planned and executed as per Approved method of statement ,and care will be taken to identify if any existing Underground cables or services and if any shall be terminated or rerouted prior to the start of work or as per Site instruction from the Employer's Representative,

5A.1.2. Preservation of Property / Amenities

Trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all facilities within or adjacent to the site which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable all safety measures as per approved method of statement by the Employer's Representative for these purposes.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc., and where required, undertake additional Works to that effect vide relevant Clauses of section 3 Before start of operations, the Contractor shall submit to the Employer's Representative for approval, his work schedule plan and method of statement for the procedure to be followed for disposal of waste materials, etc., and the schedules for carrying out temporary and permanent erosion control Works as stipulated in section 3.

5A.1.3. Methods, Tools and Equipment

Only approved methods to be executed for works , approved tools and approved equipment with valid calibration records shall be allowed by the Employer's Representative and which will not affect the property to be preserved shall be used for the Work. If the area has thick vegetation / roots / trees, suitable mechanical equipment or a Crawler or Pneumatic type Dozer of adequate capacity may be used for Site cleaning purposes. The dozer shall have ripper shanks attachments for removal of tree stumps. All trees, stumps, etc., falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500 mm of the sub-grade / foundation / bed level. Also, all vegetation such as roots, under-growths, grass and other deleterious matter unsuitable for incorporation in the Work shall be removed between fill lines to the satisfaction of the Employer's Representative. On the areas beyond these limits, trees and stumps required to be removed as directed by the Employer's Representative shall be cut down to 1 m below ground level so that these do not present any unsightly appearance. All branches of trees if any disturbing or extending above the roadway shall be permanently trimmed as directed by the Employer's Representative.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled and levelled with suitable soil material and compacted thoroughly, so as to make the surface as

these points conform to the surrounding area. Ant-hills both above and below the ground, if any are to be levelled or removed and their workings, which may extend to several meters, shall be suitably treated.

5A.1.4. Disposal of Materials

All materials arising from Clearing and Grubbing operations shall be the property of Employer and shall be disposed or shall be handed over to employer by the Contractor as hereinafter provided or directed by the Employer's Representative.

Trunks and stumps of trees shall be cleaned of limbs and roots and stacked if instructed by Employer's Representative. Also boulders, stones and other materials if instructed to be usable in construction shall be neatly stacked at specified place as directed by the Employer's Representative. Stacking stumps, boulders, stones etc., shall be done at specified spots with all lifts and lead and all rates shall be as per contract agreed and no extra pay shall be made.

All products of clearing and grubbing which, in the opinion of the Employer's Representative, cannot be used or Auctioned shall be cleared away from the Site in a specified method as directed by the Employer's Representative. Care shall be taken to see that unsuitable waste materials are disposed off in such a condition that there is no likelihood of these getting mixed up with the materials meant for construction.

5A.1.5. Measurements

Clearing and grubbing shall be measured on area basis in terms of hectares. Clearing and grubbing of borrow areas shall be deemed to be a part of Works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same. Cutting of trees up to 300 mm in girth including removal of stumps and roots, and trimming of branches of trees extending above the roadway shall be considered incidental to the clearing and grubbing operations. Removal of stumps left over after trees have been cut by any other agency shall also be considered incidental to the clearing and grubbing operations.

Cutting, including removal of stumps and roots of trees of girth above 300 mm and backfilling to required compaction shall be measured in terms of number according to the sizes given below:

- Above 300 mm to 600 mm;
- Above 600 mm to 900 mm;
- Above 900 mm to 1800 mm; and
- Above 1800 mm.

For this purpose, the girth shall be measured at a height of 1 m above ground or at the top of the stump if the height of the stump is less than 1 m from the ground.

5A.1.6. Rates

The Contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm in girth as well as stumps left over after cutting of trees carried out by another agency, excavation and back-filling to required density, where necessary, and handling, salvaging, piling and disposing of the cleared materials with all lifts and leads.

- The Contract unit rates for cutting (including removal of stumps and roots) of trees of girth above 300 mm shall include excavation and back-filling to required compaction, handling, salvaging, piling and disposing of the cleared materials with all lifts and lead.
- Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

5A.2 - DISMANTLING AND DEMOLITION

5A.2.1. Scope

This work shall consist of removing existing Buildings, Roofs, Ceiling, Flooring and Paving, Concrete and Brick works, Walls, Roofs and Suspended floors, Solid Block walls, Hordy Block works ,other Hollow Block works , Tiles , and Columns, Reinforced concrete and Brick work, Partitions, Wood work, Steel and Iron work, Doors and Windows, Pipes and Sewer lines, Lamp Posts or Struts, Fencing wire mesh, Glazing, Culverts, Bridges, Pavements, kerbs and other structures like Guard-rails, Utility services, Catch basins, Inlets, etc., which are in place and interfere with the new construction or are unsuitable to remain in place, and of salvaging and disposing of the resulting materials and back filling the resulting trenches and pits.

Existing culverts, Bridges, pavements and other structures which are within the highway and which are designated for removal, shall be removed up to the limits and extent specified in the Drawings or as indicated by the Employer's Representative.

Dismantling and removal operations shall be carried out with approved Equipment and in such a manner as to leave undisturbed, adjacent pavement, structures and any other work to be left in place.

All operations necessary for the removal of any existing structure which might endanger new construction shall be removed prior to the start of new construction work.

5A.2.2. Applicable Codes for Demolition works .

IS: 1200-1974 (Part: XVIII)	Method of Measurements of Building and Civil Engineering Works. Demolition and Dismantling (Reaffirmed 1992) (3rd Revision).
IS: 4130-1991	Demolition of Buildings - Code of Safety (2nd Revision).

5A.2.3. Terminology

The term 'Dismantling' implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the structure as specified or shown on the Drawings. The term 'Demolition' implies to destroy or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified in Site Instructions or as shown on the Drawings.

5A.2.4. Buildings

5A.2.4.1 Precautions

All materials obtained from dismantling or demolition shall be the property of the Employer unless otherwise specified and shall be either disposed to a specified place or kept in safe custody as per the instructions of the Employer's Representative. The demolition work shall always be well planned before hand and shall generally be done as per the approved method statement .. The Operations shall be approved by the Employer's Representative-In-Charge before starting the work.

Due care shall be taken to maintain the safety measures prescribed in IS: 4130 (safety code of demolition buildings). Necessary safety barrication, Supports , Propping, Shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage or Extreme noise vibration or pollution is caused to the adjoining residence, people or parallel works or Property. Wherever specified, temporary enclosures or partitions shall also be provided, as directed by the Employer's Representative. Necessary precautions shall be taken to keep down the dust pollution to the minimum level and prevention methods like watering or as per site instruction by the Employer's Representative shall be followed. Dismantling shall be done in a systemic manner. All materials which are likely to be damaged due to dropping from a height or by demolishing roofs, masonry walls etc. shall be carefully removed as per approved method . The dismantled articles shall be removed manually or by approved cranes or otherwise lowered to the ground without throwing and properly stacked as directed by the Employer's Representative. If any existing structures are fixed by nails, screws or bolts, rivets, etc., dismantling shall be done with proper tools and not by tearing or ripping off. Any Reusable or serviceable materials are obtained during dismantling or demolition, shall be separated and stacked as directed by the Employer's Representative within a lead of 50 m. All unserviceable materials, garbage or Debris, rubbish etc. shall be disposed off as directed by the Employer's Representative. The Contractor shall maintain / disconnect existing services, whether temporary or permanent, where required by the Employer's Representative.

5A.2.4.2 Measurements

All work shall be measured as per IS standards of measurement in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter.

1. Dimensions shall be measured correct to a cm (centimetre)
2. Areas shall be worked out in sq mt correct to two places of decimal.
3. Cubical contents shall be worked out to the nearest 0.01 cum.(M3)

All parts of work required to be dismantled and demolished shall be measured separately. Measurements of all works except hidden work or under ground services shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed. Specifications for deduction for voids, openings etc. shall be done on the same basis as adopted for new construction work.

Work executed in the following conditions shall be measured separately and with separate approved Price as per Site Instructions :

1. Work in or Under water / Under Ground below 1 m and / or Liquid mud / Marsh clay / Slushy soil
2. Work in or under foul position / Sewage tank or Sewage area .

5A.2.4.3 Rates

The rate shall include the total cost of all employees ,administrative , super vision and direct labours involved ,Equipments, Machineries, cranes ,Loaders, Showels, Dozers, if any other Specified and other tools used in demolishing and dismantling including Supports , Safety methods , scaffolding and all necessary tools and Shackels and other Resources and if any Risk Involved . The rate shall also include the charges for separating out or segregating and stacking the serviceable material and disposing off unserviceable material within a distance of 50 m as per approved method of statement. The rate shall also include for temporary shoring, protection for the safety of portions without any damage to adjacent

structures or neighbourhood or to adjoining property, and providing temporary enclosures or partitions, where ever considered necessary to be provided as per Site condition .

5A.2.5. Roofs and Measurements

Roof coverings generally includes ,battens boarding, mats, bamboo or other subsidiary supports shall be measured in sq mt except Lead sheet roof covering, which shall be measured in tonnes and stone slab roof covering which shall be measured in cum. Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed. Mud phuska on roofs shall be measured in cum. Lead sheets in roofs shall be measured in tonnes or as per IS code standard and hips, valleys, flashings, lining to gutter etc. shall be included in this weight. R.B(Reinforced Brick) . or (Reinforced Cement Concrete) R.C.C. roofs shall be measured in cum and if reinforcement is required to be salvaged, it shall be stated during pricing quotation . When reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately as tonnes of salvaged steel. Supporting members, such as rafters, purlins, beams joists, trusses etc. where as wood, for example doors , windows shall be measured in cum and steel or iron girders, purlins , H BEAMS, I BEAMS etc . sections in tonnes.

5A.2.6. Ceiling and Measurements

The stripping of Ceilings shall be measured in sqm. Dismantling of supporting joists, beams, etc. shall be measured in cum or in tonnes. Height above floor levels if it exceeds 3.5 m shall be paid separately. All pricing shall include safety works, delivery distance and other critical works involved during demolition or dismantling.

5A.2.7. Flooring and Paving

Dismantling of floors and Paving (except concrete and brick floors) shall be measured in sqm. Supports such as joints, beams etc. if any shall be measured as per Clause 5A.2.5.6. Concrete and bricks paving shall be measured as per Clause 5A.2.8.

5A.2.8. Concrete and Brick Roofs and Suspended Floors and Measurements

Demolition of floors and roofs of concrete or brick shall be measured in cum. Beams cantilevers or other subsidiary supports of similar materials shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen, felts, the thickness of water proofing treatment shall be ignored.

5A.2.9. Walls and Piers

Taking down walls and independent piers or columns of brick, stone or concrete shall be measured, in cum (Cubic Metre). All copings, corbels, cornices and other projections shall be included with the wall measurements. In measuring thickness of plastered walls, the thickness of plaster shall be ignored. Ashlar face stones, dressed stone work, precast concrete articles, etc. if required to be removed safely it shall be so stated, and measured separately in cum. Cleaning bricks stacking for measurements including all extra handling and removal and disposing off the rubbish as stated shall be counted or enumerated in thousands of cleaned bricks. Cleaning stone obtained from demolished / dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and precast concrete blocks including all extra handling and disposing of the rubbish as stated shall be measured in cum of cleaned stone . Honeycomb works or cavity walls of bricks stone or concrete shall be measured as solid.

5A.2.10. Reinforced Concrete and Brick Work and Measurements.

Reinforced concrete structures and reinforced brick roof and walls shall be measured in cum and if reinforcement is required to be salvaged, it shall be so stated. Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in tonnes of salvaged or recovered steel.

5A.2.11. Partitions, Trellis Work, Etc and Measurements .

Partitions or light walls of lath and plaster, trellis work, expanded metal, thin concrete or terracotta slabs and other similar materials including framework if any shall be measured in sqm stating the overall thickness.

5A.2.12. Woodwork and Measurement

All wood work with average 40 sq cm or over in section, shall be measured in cum, while that under 40 sq cm in section, in running metres. Ballies shall be measured in running metres. Boarding including wooden chajjas and sunshades along with supports shall be measured in square meter (Sq m) in its plane. All wood works to be removed or demolished shall be priced as per site condition .

5A.2.13. Steel and Iron Work and Measurement

All steel and iron Dismantling or demolition work shall be measured in tonnes. The weight shall be computed from standard tables unless the actual weight can readily be determined. Riveted work, where rivets are required to be cut, shall be measured separately. Marking of structural steel required to be re-erected shall be measured separately. In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

5A.2.14. Doors and Windows and Measurements

Dismantling of doors, windows, clerestory windows, ventilators etc. (Wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of architraves, hold fasts and other attachments. If only shutters are to be taken out it shall be measured separately. All measurements shall be as per Method of statement approved by Employer's Representative incharge .

5A.2.15. Pipes and Sewer Lines and Measurements

Water pipe lines includes rain water pipes, storm water pipes and drain pipes and all PVC pipes, with clamps and special sewer lines (salt glazed ware pipes ,RTR Reinforcement thermosetting resin piping or concrete pipes) etc. shall be described by diameter and length measured in running metre (m) inclusive of joints. If the joints, special and fittings etc. are required to be separated, it shall be stated and enumerated. All Drains shall be measured under relevant items. Other items like Valve cistern, public fountain platform, fire hydrants, etc. shall be enumerated. Manholes and inspection chambers shall be enumerated with the size and depth of manhole / Manhole inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one metre (m) depth. The depth of the manhole shall be the distance between the top of manhole cover and invert level of the

drain. Ventilating shafts, Gully traps, Flushing Cisterns and other appurtenant items of work shall be enumerated.

5A.2.16. Posts or Struts and Measurement

Posts or Struts, Purlins (wood, steel or RCC) section including taking out embedded portion shall be measured in running metre (m).

5A.2.17. Fencing Wire Mesh and Measurements

Wire Mesh fencing of any type with frame shall be measured in square metre (sqm).

5A.2.18. Glazing and Measurements

Removing off any serviceable glass (window glass)fascade glasses except polished plate, from old sashes, skylights, etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square metre (sqm). Irregular or circular panes shall be measured as rectangle or square enveloping the same, the width and height being measured correct to the nearest 0.5 cm. All measurements shall include as per approved method of statements and pricing shall include all critical issues including machineries , equipment, cranes and workers and supervision and administrative cost .

5A.2.19. Dismantling Culverts, Bridges and Other Structures / Pavements

5A.2.19.1 Dismantling Culverts and Bridges

The structures shall be dismantled carefully and the resulting materials removed shall not cause any damage to other serviceable materials to be salvaged, the part of the structure to be retained and any other properties or adjacent structures . Unless otherwise specified, the superstructure portion of culverts / bridges shall be entirely removed and other parts removed below the ground level or as necessary depending upon the interference they cause to the new construction. Removal of overlaying or adjacent material, if required in connection with the dismantling of the structures shall be incidental to this item.

Where existing culvert / bridges are to be extended or otherwise incorporated in the new work, only such part or parts of the existing structure shall be removed as necessary and directed by the Employer's Representative to provide a proper interface and connection to the new work. The connecting or interfaces and all edges shall be cut, chipped and trimmed to the required lines and grades without weakening or damaging any part of the structure to be retained. Due care shall be taken to ensure that reinforcing bars which are to be left in place to project into the new work as dowels or ties that are not damaged during removal of concrete. Pipe culverts shall be carefully removed to avoid damage to the pipes.

Steel structures , unless specified shall , be carefully dismantled in such a manner as to avoid damage to members thereof. If specified in the Drawings or shop drawings or directed by the Employer's Representative that the structure is to be removed in a condition suitable for re-erection, all members shall be match-marked by the Contractor with white colour lead paint before dismantling; end pins, anchor bolts , nuts, loose plates, etc., shall be similarly marked to indicate their proper location; all pins, pin holes and machined surfaces shall be painted with a mixture of white lead and tallow and all loose parts shall be securely wired to adjacent members or packed in boxes.

Timber structures shall be removed in such a manner to avoid damage to such timber or lumber when designated by the Employer's Representative that has to be salvaged.

5A.2.19.2 Dismantling Pavements and Other Structures

In removing pavements, kerbs , drainage ,gutters and other structures like guard-rails, fences, manholes, catch-basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed or specified by the Employer's Representative. All concrete pavements, base courses in carriageway and shoulders etc., designated for removal shall be broken to pieces and volume shall not exceed 0.02 cum and stockpiled at designated locations if the material is to be used later or otherwise arranged for disposal as directed by the Employer's Representative . (see Clause 5A.2.19.4)

5A.2.19.3 Back-filling

Side filling of the RCC wall and other excavated portion shall be back filled and other Holes and undulations or depressions caused by dismantling operations or any other works shall be backfilled with excavated or other approved materials or imported fill materials or specified materials shall be compacted to required density or as directed by the Employer's Representative or as per Approved method of statement ..

5A.2.19.4 Disposal of Materials

All materials obtained by dismantling shall be the property of Employer. Unless otherwise specified .. Materials having any salvage value shall be placed as directed in neat stacks of like materials within the right-of-way or , as directed by the Employer's Representative with all lifts and up to a lead of 1000 m.

Pipe culverts that are removed shall be cleaned and neatly piled on the right-of-way at points designated by the Employer's Representative with all lifts and lead up to 1000 m.

Structural steel removed from old structures shall, unless otherwise specified or directed, shall be stored in a neat and accountable or presentable manner on blocks in locations suitable for loading or resalable manner , Auctionable Manner . Structures or portions thereof which are specified in the Contract for re-erection shall be stored in separate Racks or piles. Timber or lumber from old structures which is designated by the Employer's Representative as materials to be salvaged if shall have all nails and bolts shall be removed there from and shall be stored in neat piles in locations suitable for loading. All materials obtained from dismantling operations which, in the opinion of the Employer's Representative, cannot be used or auctioned shall be disposed of as directed by the Employer's Representative with all lifts and up to a lead of 1000 m.

5A.2.19.5 Disposal of Materials

The work of dismantling structures shall be paid for in units indicated below by taking measurements before and after, as applicable:

1.	Dismantling brick/stone masonry/concrete (plain and reinforced)	cum.
2.	Dismantling flexible and cement concrete pavement	cum.
3.	Dismantling steel structures	tonne
4.	Dismantling timber structures	cum.

5.	Dismantling pipes, guard rails, kerbs, gutters and fencing	linear m.
6.	Utility services	Nos.

5A.2.19.6 Rates

The Contract unit rates for the various items of dismantling shall be paid in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment, safeguards and incidentals necessary to complete the work. These will also include excavation and backfilling where necessary to the required compaction and for handling, salvaging, piling and disposing of the dismantled materials within all lifts and up to a lead of 1000 m.

5A.3 -EARTHWORKS

5A.3.1. 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.

- | | | | |
|----|------------------|---|--|
| a) | IS 783 - 1985 | - | Code of practice for laying of concrete pipes. |
| b) | IS 3764 - 1992 | - | Excavation work - Code of Safety. |
| c) | IS 2720 | - | Methods of test for soils |
| | (Part-1) - 1983 | - | Preparation of dry soil samples for various tests. |
| | (Part-2) - 1973 | - | Determination of Water Content. |
| | (Part-4) - 1985 | - | Grain size analysis. |
| | (Part-5) - 1985 | - | Determination of liquid and plastic limit. |
| | (Part-7) - 1980 | - | Determination of water content - dry density relation using light compaction. |
| | (Part-9) - 1992 | - | Determination of dry density - moisture content by constant weight of soil method. |
| | (Part-14) - 1983 | - | Determination of density index (relative density)
Cohesionless soils. |
| | (Part-22) - 1972 | - | Determination of organic matter. |
| | (Part-26) - 1987 | - | Determination of pH Value. |
| | (Part-27) - 1987 | - | Determination of total soluble sulphates. |
| | (Part-28) - 1974 | - | Determination of dry density of soils in place, by the sand replacement method. |
| | (Part-33)-1971 | - | Determination of the density in place by the ring and water replacement method. |
| | (Part-34) – 1972 | - | Determination of density of soil in place by rubber balloon method. |
| | (Part-38) – 1976 | - | Compaction control test (Hilt off Method). |

5A.3.2. Drawings

Contractor along with Employer's Representative's coordination will furnish approved drawings both shop drawings and main drawings with all Reference levels wherever, in his opinion, such drawings are required to show areas to be Excavated / Filled Graded or Levelled , sequence of priorities with look ahead schedule for three weeks consequent work plan and other accessories etc. Contractor shall follow strictly such approved Plan and AFC (Approved for Excavation and Construction) drawings.

5A.3.3. General

The Contractor shall furnish prior to start of work all safety warnings and barrication as per safety officer instructions and also approved and certified and calibrated Tools, Plant, Instruments, and Qualified Supervisory Personnel, Labour, Materials, Any other Temporary Works, Consumables, and all necessary items that are specifically stated herein for completion of the work in accordance with the Specifications.

The Contractor shall Survey the Site before excavation and set out all Temporary and Permanent Grid lines and establish Benchmarks and reference levels for all works required for works including for Grading, Basement, Foundations, Plinth Filling, Roads, Drains, Cable Trenches, Pipelines etc. Such survey shall be carried out as per Method of Statement prepared by Contractor and approved by the Employer's Representative. and for few works Accurate cross sections of the area perpendicular to established reference / Grid lines at 8m intervals or nearer, if necessary, based on ground profile and recorded accurately.

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

The rates shall be as per approved BOQ as quoted shall also include for dumping of excavated material 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. Hard Rocks shall be stacked separately.

Topsoil shall be stock piled separately if approved for later re-use or else shall be carted away.

5A.3.4. Clearing

The area to be excavated / filled shall be cleared if any from 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 to a designated place as approved by the Employer's Representative. Where earth fill is intended, the area shall be stripped of all Loose / Soft patches, Topsoil containing objectionable matter / materials before fill commences.

5A.3.5. Classification of Excavated materials

All materials to be excavated shall be classified by Employer's Representative, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of Employer's Representative regarding the classification of the material shall be final and binding on Contractor and not be a subject matter of any appeal or arbitration.

Any earthwork will be classified under any of the following categories:

5A.3.5.1 Ordinary & Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, Murom and / or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "soft and decomposed rock" and "hard rock" defined below. This shall also

include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in width or depth directions.

5A.3.5.2 Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite, highly weathered granite gneiss and all other materials which in the opinion of Employer's Representative is rock, but does not need blasting and could be removed readily with pick -hacks, hammer, spade crow bars, wedges, and pneumatic breaking equipment . Contractor if uses blasting for reasons of his own without approval of the Employer's Representative , shall not qualify for classification under 'hard rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

5A.3.5.3 Hard Rock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting, chiselling or by drilling with heavy mechanical breakers ,rock breakers . Harder varieties of rock with or without veins and secondary minerals which, in the opinion of Employer's Representative require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

Before classification of material as rocks, the Contractor shall demonstrate to the satisfaction of the Employer's Representative, his suggestions and difficulties and unable to excavate it without resort to heavy percussion tools complete with rock bits, hydraulic wedges or blasting. Excavation by the use of explosive will not normally be permitted. Special permission can be made as suggestions for Controlled Blasting.

Material shall not be classified as rock unless the Employer's Representative has agreed to such classification on the basis of such a demonstration before its excavation. Excavations where rock has been encountered and classified as such shall not be backfilled before examination of the excavated faces by the Employer's Representative to enable the extent of the rock excavation to be determined.

5A.3.6. Excavation

All excavation work shall be carried out after Approval from by designated Safety officer with 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 are as 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 as per approved drawings to a depth of 150mm 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 of grade M10 with 40 mm downgraded aggregates as approved by the Employer's Representative. The final excavation should be carried out just prior to laying the blinding course.

Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by Employer's Representative, at his own cost outside the lines shown on the drawings or directed by Employer's Representative. Should any excavation be taken below the specified elevations,

Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra work shall be claimed by Contractor on this account unless specially approved by the Employer's Representative.

All excavations shall be to the minimum specified dimensions required for safety and ease of working. Prior approval from 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 or some areas stepped slope shall be adopted as per Employer's Representative Site Instructions. 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. Removal of the slipped earth will not be paid for if the slips are due to the negligence of Contractor.

5A.3.7. 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 and the site is Inspected and approved by the Safety officer. 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. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question and shall be recommended for Billing by the approved Employer's Representative.

5A.3.8. Excavation in Hard Rock

5A.3.8.1 General Requirements

Unless otherwise stated herein, I.S. Specification "IS- 4081(1986) Safety code for Blasting and related Drilling Operations" shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Employer's Representative. As far as possible all types approved blasting or controlled Blasting as per Approved method of Statement shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the maximum possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by the Employer's Representative, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, or adjacent residence or Structures Contractor shall take special care and repair the same to the satisfaction of the Employer's Representative at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of the Employer's Representative will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by the Employer's Representative, the rock shall be removed by drilling, wedging,

pick, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from Employer's stores or from supplier arranged by him, from the authorities dealing with explosives. All fees, if any, required for obtaining such license, and other permits and fees for approval from Government bodies shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Government authorities and Statutory bodies / regulations. Explosives shall be kept dry and shall not be exposed to direct rays of sun or be stored in the vicinity of fire, stoves, steam pipes or heated metal, etc and Inspected by Safety Officer and Approved from Safety Officer. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as far as possible away from the area to be blasted, Employer's Representative's prior approval shall be taken for the location proposed for the magazine.

In no case shall blasting / controlled blasting shall be allowed closer than 30 meters to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 21 days old.

In the case of water pipeline works etc. for water transfer, the following stipulations shall over-ride the corresponding stipulations in "General Requirements" given above:

Excavation in hard rock shall be only by chiseling / Jack hammering or by drilling or with mechanical brakers approved by Employer's Representative and Safety officer.

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. The unit rate for excavation in hard rock shall include the cost of all these operations. No blasting is allowed for soft rocks.

5A.3.8.2 Specific Requirements

For blasting operations, the following points shall be observed.

Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Employer's Representative and obtain his approval in writing for performing such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m. radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be given warning by sounding a distinguishing whistle by the Approved Safety officer.

The blasting of rock near any existing buildings, equipment or any other property shall be protected or done with under cover if permitted by the Employer's Representative and Contractor has to make all such necessary muffling / Precautionary safety arrangements or as per approved method of Safety Statements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Employer's Representative, a

trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively or as per IS code of Practice. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after one hour and water shall be used for making it inactive and a new point on rock shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it or as per IS code) and by exploding a new charge.

A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.

Contractor shall preferably detonate the explosives electrically or as per Approved Method of Statement. The explosives shall be exploded by means of a primer which shall be fired by detonating a

Fuse Instantaneous Detonator (F.I.D) or other approved cables. The detonators with F.I.D shall be connected by special nippers.

In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be used. Under water or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

Holes for charging explosive shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Employer's Representative, with concrete of strength not less than M100 (design ratio of 1 : 0.617 : 1.644) (The Mix Proportion for M100 grade concrete is derived as 1 : 0.617 : 1.644 by following the design procedure given by ACI Method. By maintaining the w/c ratio as 0.25, the 28-day strength of concrete has been obtained as 153.46 N/mm² at 6% silica fume and 1.5% of Rheo build). The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stopping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other Authority duly constituted under the State and /or Union Government.

5A.3.9. Excavation under water.

Neat trenches shall be excavated for placing aprons, cut off walls and lower portions of headwalls or wing walls. The excavation shall be dewatered to prevent disturbing the natural soil conditions at the base of the excavation and to permit completing all construction operations in the dry.

Dewatering shall be accomplished by constructing trenches around the outside perimeter of the culvert bed and by excavating sump pits to a depth of not less than 2.0 meters below the bottom of the culvert base, or by other means subject to the Engineer's approval. When trenches and sump pits are used, the excavation shall be shored or braced with cribs to permit pumping.

The equipment used for excavation purposes may travel or move on the base of the excavation only if it does not disturb the base of the excavation. All additional excavation and backfilling required as a result of the improper use of equipment for excavation purposes shall be done at the Contractor's own expense.

Cofferdams to isolate the excavation from the waterway shall be constructed as per standards and as approved by the Employer's Representative.

5A.3.9.1 Dewatering

Excavations shall be dewatered such that the construction of the foundations is completed in the dry. The bottom of the excavation shall be kept free from excessive moisture and free-flowing water. Underwater excavation will not be allowed other than under extreme conditions where the ingress of water from the bottom of the excavation is impossible to stop.

Pumping from the interior of any excavation shall be done so that the water is diverted from the footing base. The level of any water inside of the excavation shall be below the bottom of the footing elevation so that the foundations are placed in the dry. Pumping water from the excavation shall not be discontinued until the substructure unit is completed and backfilled unless otherwise allowed by the Engineer.

5A.3.10. Fill, Backfilling and Site Grading

5A.3.10.1 General

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.

The Contractor shall not commence the placement of any fill or backfill at any location without the approval of the Employer's Representative.

5A.3.10.2 Material

To the extent available, selected surplus soils from excavations 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 Murram 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. Topsoil 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 temporary access roads with (approved shop drawings) to borrow areas and maintain the same if such roads do not exist, at his cost.

5A.3.10.3 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 or by approved fill

material 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 as per approved method of statement and as per approved Drawing. Earth shall be compacted and rammed with periodically Calibrated and checked by safety officer and 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.

5A.3.10.4 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 or approved rollers with specified tons, 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 spraying, and sprinkling shall be done to assist consolidation. Water shall be sprinkled as per approved method in case of sandy fills. All works shall be carried as per Approved method of Statements.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300mm. The Contractor will determine or identify 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 commencement of 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 specified 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.

5A.3.10.5 Sand Filling in Plinth and Other Places .

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities, organic matters or any chemicals, oil, grease, or other Debris. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be on Contractor's account. 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.

5A.3.10.6 Backfilling for Offshore Pipeline and Related Structures.*Intake Pipeline*

Once the entire offshore length of intake pipeline has been laid and the final position controlled by positioning system is assured, the sand backfilling can start ensuring that the extremities of the line at the intake chamber and spool piece end at intake screen location remains free for the future connection to the onshore equipment and to the offshore intake screen installation. Backfilling shall be carried out using the natural excavated material if suitable. If the excavated material is not suitable, the contractor shall encase the pipe with sand up to a 500 mm thick all-around. Contractor shall take due care during the backfilling so that the backfill material should not damage the Intake pipe surface. The backfilling shall be carried out in stages in order to allow the sand to be deposited, duly compacted and to match, the original sea bottom configuration. Prior to the work progress, the Contractor shall submit the pipeline laying profile to the employer for approval and works shall be carried out accordingly. Intake Structure Area

After the installation of the Intake structure and its connection to the HDPE submarine pipeline with special spool piece, the area surrounding the Intake structure shall be protected by covering a layer of stones of 25-50 Kg up to a depth of minimum 3 m below the natural seabed level and up to 50m around the Intake structure. Above this another layer of 2.0 m height of larger stones (100 – 200 Kg sizes) stacking shall be carried out around the Intake structure. Nylon net shall be installed all around with floating buoys.

The Intake structure must be modelled in order to establish the structural stability, so that it can able to support the forces generated by the under currents in the worst case scenario. The Intake tower head should be anchored to the hard strata below the seabed level and kept above 300mm from the seabed level. The Intake tower should be supported and surrounded by the Gravel fill from the sea bed to prevent the entry of sediment/sand into the Intake screen. Outfall Pipeline and Diffusers Area

Similar to the above, the backfilling operations for the entire length of Outfall pipeline, shall be carried out by Contractor in order to return to the original configuration of the seabed. The area where the diffuser's manifold has to be installed, shall be protected by covering a layer of stones of 25-50 Kg up to a depth of minimum 3 m below the natural sea bed level and up to 70m around the Outfall structure. Above this layer, another layer of 2.0 m height of larger stones (100 – 200 Kg sizes) stacking shall be carried out around the Outfall structure. These dimensions are indicative. However, the Contactor has to provide the proper justification to protect the Intake and Outfall structure surroundings.

Outfall Diffusers Installation

Based on the Brine dispersion analysis, the contractor has to design the diffusion configuration and structure. All diffusers are blind flanged, and flanges shall be removed by divers after the installation of the Outfall and Intake is completed. The Outfall structure must be modelled in order to establish the structural stability, so that it can able to support the forces generated by the under currents in the worst case scenario. The Outfall structure/ manifold should be anchored to the hard strata below the sea bed level.

5A.3.10.7 Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be well consolidated and tested by Approved Quality Control Employer's Representative and supervisory and checked for watering and ramming, and also due care is taken 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 center 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 center line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling up to a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murrum, or approved fill material etc. The filling up to the level of the center line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the center line of the pipe shall be done by hand compaction or approved small compactors or mechanical 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.

In the case of water pipeline works etc. for water transfer, the Contractor shall take proper precautions against the risks of floatation. Should any section of the pipeline be affected by floatation in the course of works the entire work or that part of the work shall be removed or rectified and then reinstalled to the satisfaction of Employer's Representative.

5A.3.11. General Site Grading

Site grading shall be carried out as indicated in the Approved for Construction drawings and as approved by the Employer's Representative. Excavation shall be carried out as specified in the Specifications. Filling and compaction shall be carried out as specified under Clause 5A.3.9 and elsewhere unless otherwise indicated below.

The fill has to be compacted in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 5A.3.9 before the next layer is made / deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his own cost. Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. 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 condition, for the slope and level in the slip at his cost.

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 cm 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.

5A.3.12. Fill Density

The compaction, where so called for, shall comply with minimum 95% Modified Proctor density 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.

5A.3.13. Lead

Lead for deposition/disposal of excavated material, shall be as specified in the respective item of work. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or rough road (sand and soil compacted road), soil 'katcha' land mud land / mud route.

5A.3.14. Measurements

All excavation shall be measured net as per Approved Drawings. Dimensions for purpose of payment shall be $L \times B \times D$ (LENGTH (M) X BREADTH (M) X DEPTH (M)=M³) reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations / structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the AFC (Approved for construction) drawings. Excavations in side slopes will not be paid for. Contractor may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation. Reasonable working space, beyond concrete dimensions and shuttering where considered necessary in the opinion of Employer's Representative will be allowed in excavation and considered for payment or as per IS code of practice for measurement shall be adopted. However, if concreting is proposed against the excavated sides, no such over-excavation will be permitted. In such cases over-excavation shall be made good by Contractor with concrete of the same class as in the foundations at his own cost.

In the case of water pipeline works etc. for water transfer trench excavation shall be measured using the dimensions detailed in the standard section shown on the Drawings. No payment will be made for working space except where clearly mentioned on the drawings. Excavation beyond the widths or depths required will not be paid for any additional concrete or bedding material required as a result of over-excavation at the Contractor's expense.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule, material to be backfilled shall be stacked temporarily within the basic lead of 100 meters unless otherwise directed by the Employer's Representative. If Employer's Representative directs / permits a lead of over 100 meters for such material, the conveyance of the material for the extra distance over the basic lead of 100 meters for backfilling will be paid.

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified / directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth / trench dimensions as per drawings. The plinth ground levels shall be surveyed beforehand for this purpose. If no compaction is specified / desired such filling will not be separately paid for. In such an event the fill shall be leveled / finished to the profile as directed at no extra cost.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc., as specified. Actual quantity of consolidated filling or actual quantity of excavation in the borrow pits (less such

topsoil which has been excavated and not used for filling) whichever is less shall be measured and paid for in cubic meters. The lead, lift etc. shall be as indicated in the schedule of quantities.

Actual quantity of consolidated sand filling shall be measured and paid in cubic meters.

Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the drawings. No payment will be made for excavations / overbreak beyond payment line specified unless approved by the Employer's Representative. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by Employer's Representative and the volume of rock calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by Employer's Representative and this will not be a subject matter of dispute or appeal.

5A.3.15. Timber Shoring

Close timbering shall be done as per approved method of statement and by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Employer's Representative. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walings of strong wood at maximum 1.2-meter spacings, struttled with ballies or as approved by the Employer's Representative. The length of the ballie struts (Horizontal support strut) shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walings, which in turn shall be suitably struttled. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

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

Timber shoring may also 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 spacings shall be subject to the approval of the Employer's Representative. In all other respects, the Specifications 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 struttled 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. If however, Employer's Representative directs the contractor to remove any timbering to be left-in, based on the

type of construction or any other condition, Contractor shall be paid for at the scheduled item rate for such left-in timbering. Serving for extra time and extra support

5A.3.16. Measurement

All Measurements shall be as per IS Construction code of practice of measurement standards and as per Contracts Agreed and Approved Bill Of Quantities. Unless separately provided for in the Schedule of Quantities, the actual effective area of shored faces as approved by Employer's Representative shall be measured in sq.m.(Square Meter). The area of planking embedded in the bed / sides of excavation will not be considered, nor the area supporting inclined struts in case of large pits / open excavation. All planks, boards, walings, verticals, struts, props and all other materials required for shoring and subsequent safe dismantling and removal shall be included in the quoted unit rates.

5A.3.17. 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 / rainwater so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction program. Sumps made for dewatering must be kept clear of the excavations / Trenches required for further work. The method of pumping / Dewatering 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. All dewatering shall be carried out as per Approved Method of Statement.

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 buildup 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 based on the water table report from soil test report, and the number, capacity and location of pumps for approval. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included along with / in the item rate for Excavation.

5A.3.18. Measurement

Unless separately provided for in the Schedule of quantities, dewatering is deemed to have been included in the unit rates quoted for excavation. If separately provided for, the unit of measurement shall be as indicated in the Schedule of Quantities.

5A.3.19. Rain Water Drainage /Pumping

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.

5A.3.20. Earthen Embankment Construction

5A.3.20.1 Scope

These Specifications shall apply to the construction of embankments including sub grades, Earthen shoulders and miscellaneous backfills with approved materials obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrade, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections shown on the Approved Drawings or as directed by the Employer's Representative.

5A.3.20.2 Physical Requirements of materials

The materials used in Embankments, Sub grades, Earthen shoulders and miscellaneous backfills shall be soil, murrum, gravel, a mixture of those or any other material approved by the Employer's Representative. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment / Subgrade.

The following types of material shall be considered unsuitable for embankment:

Materials from swamps, marshes and bogs;

Peat, log, stump and perishable material; any soil that classifies as OL, OI, OH or Pt in accordance with IS: 1498.

Materials susceptible to spontaneous combustion;

Materials in a frozen conditions;

Clay having liquid limit exceeding 70 and plasticity index exceeding 45; and

Materials with salts resulting in leaching in the embankment.

Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 percent when tested as per IS: 2720 Part 40) shall not be used as a fill material. Where expansive clay with acceptable "free swelling index" value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non-expansive in nature.

Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO₃) per liter when tested in accordance with BS: 1377 Test 10, but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as SO₃) exceeding 0.5 percent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the subgrade. However, the Employer's Representative may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle size shall not be more than two-thirds of the compacted layer thickness.

Ordinarily, only the materials satisfying the density requirements given in Table 5-3 shall be employed for the construction of the embankment and the subgrade.

Table-1. Density Requirements of Embankment and Subgrade Materials

Sl. No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS: 2270 (Part 8)
1.	Embankments up to 3 meters height, not subjected to extensive flooding.	Not less than 15.2 kN / cum.
2.	Embankments exceeding 3 meters height or embankments of any height subject to long periods of inundation	Not less than 16.0 kN / cum.
3.	Sub grades and earthen shoulders / verges / backfill	Not less than 17.5 kN / cum.

Notes:

This Table is not applicable for lightweight fill material e.g. cinder, fly ash etc.

The Employer's Representative may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

The material to be used in subgrade should also satisfy design CBR (The Californian Bearing Ratio test is a penetration test used to evaluate the subgrade strength of roads and pavements.) at the dry unit weight applicable as per Table-II.

5A.3.20.3 General requirements of materials

The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

5A.3.20.4 Borrow Materials

Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Employer's Representative and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer / the Employer's Representative, arrangement for locating the source of supply of material for embankment and subgrade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Employer's Representative, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plants is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Employer's Representative, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Employer's Representative. It shall be ensured that the subgrade material when compacted to the density requirements as in Table II shall yield the design CBR value of the subgrade.

Table-II . Compaction Requirements for Embankment and Subgrade

Sr	Type of work/ material	Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)
1.	Subgrade and earthen shoulders	Not less than 97
2.	Embankment	Not less than 95
3.	Expansive Clays	
	a) Subgrade and 500 mm portion just below the subgrade	Not allowed
	b) Remaining portion of embankment	Not less than 90

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Employer's Representative for approval:

The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

A graph of density plotted against moisture content from which each of the values in (1) above of maximum dry density and optimum moisture content were determined.

The Dry density-moisture content-CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Employer's Representative, it shall be the basis for compaction.

5A.3.20.5 Construction Operations for Embankments

Setting out

After the site has been cleared to Section-1, the work shall be set out. The limits of embankment / subgrade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment / subgrade shall be built sufficiently wider than the design

dimension so that surplus materials may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

Dewatering

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Employer's Representative it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Employer's Representative and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair / restore it to original condition or compensate the damage at his own cost. If the embankment is to be constructed under Water, Clause 5A.3.19.6 shall apply. All dewatering shall be done as per approved method of Statement.

Stripping and storing topsoil

In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Employer's Representative, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept minimum.

Compacting ground supporting Embankment / Subgrade .

When necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table-II.

In case where the difference between the subgrade level (top of the subgrade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 percent relative compaction with respect to the dry density as given in Table 5-4, the ground shall be loosened up to a level 0.5 m below the subgrade level, watered and compacted in layers in accordance with Clause 5A.3.19.4 to not less than 97 percent of dry density as given in Table-II.

Where so directed by the Employer's Representative, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction as per Employer's Representatives Instructions.

Embankment or subgrade work shall not proceed until the foundations of embankments/subgrade have been inspected by the Employer's Representative for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Employer's Representative. Where the ground on which and embankment is to be built has any of the material types specified in Clause 5A.3.19.2, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

Spreading material in layers and bringing to appropriate moisture content

The embankment and subgrade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 5A.3.19.4. The motor grader blade shall have hydraulic

control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table-II and got approved by the Employer's Representative. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such construction, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surfaces but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until a uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1% above to 2% below the optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

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

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the subgrade.

Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Employer's Representative, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 5A.3.19.5 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Employer's Representative by tracking a tracked vehicle, considered suitable by the Employer's Representative, on the slope or by any other approved method of statement accepted or approved by the Employer's Representative

Compaction

Only the compaction equipment approved by the Employer's Representative shall be employed to compact the different material types encountered during construction. Smooth wheeled, vibratory, pneumatic tyer, sheep foot or pad foot rollers, etc., of suitable size and capacity as approved by the Employer's Representative shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic tyer roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficiency of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Employer's Representative for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 5-4. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 of MoST Specifications for Roads and Bridge Works (IV Revision) and accepted by the Employer's Representative. The Employer's Representative may permit measurement of field dry density by a Nuclear moisture density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identified to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurement reveals any soft areas in the Embankment / Subgrade / Earthen shoulders, further compaction shall be carried out as directed by the Employer's Representative. If in spite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Employer's Representative. All the Records of works shall be maintained by the Quality control Employer's Representative at Site

Drainage

The surface of the embankment / subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

Repairing of damages caused by rain / spillage of water

The soil in the affected portion shall be removed in such areas as directed by the Employer's Representative before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer etc to achieve the required density in accordance with Clause 5A.3.19.5. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Employer's Representative to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery / equipment for the purpose.

Finishing operations for Excavation.

Finishing operations shall include the work of shaping and dressing the shoulders / verge / roadbed and

side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the Drawings or as directed by the Employer's Representative subject to the surface tolerance described in **Clause 902** of MoST Specifications for Roads and Bridge Works (IV Revision). Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, that was removed and conserved earlier shall be spread over the fill slopes as per directions of the Employer's Representative to facilitate the growth of Vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with **Clause 5A.3.20**. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of **Clause 5A.3.21**.

When Earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly, untidy scars in the construction area responsible for objectionable appearance shall be eliminated, rectified and the area shall be Inspected and approved by the Employer's Representative

5A.3.20.6 Construction of Embankment and Subgrade under Special Conditions

Earthwork for widening existing road embankment

When an existing embankment and / or subgrade is to be widened and its slope are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment / subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment / subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of periodically calibrated small vibratory rollers / plate compactors / power rammers of any other appropriate equipment approved by the Employer's Representative. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

Earthwork for Embankment and Subgrade to be placed against sloping ground:

Where an embankment / subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed / scarified as required in **Clause 5A.3.19.5** before placing the embankment / subgrade material. Extra earthwork involved in benching or due to ploughing / scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall subsoil drains at the lowest point shall be provided as per the Drawings, before the fill is placed against sloping ground.

Earthwork over existing road surface:

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

If the existing road surface is of granular or bituminous type and lies within 1 m of the new subgrade level, the same shall be scarified to a depth of 50 mm or more if specified, so as to provide ample bond

between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired approved Moisture density.

If the existing road surface is of cement concrete type and lies within 1 m of the new subgrade level the same shall be removed completely.

If the level difference between the existing road surface and the new formation level is more than 1 m, the existing surface shall be permitted to stay in place without any modification.

Embankment and subgrade around structures:

To avoid interference with the construction of abutments, wing walls or return walls of culvert / bridge structures, the Contractor shall, at points to be determined by the Employer's Representative suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Employer's Representative but in any case, not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be approved from the Employer's Representative.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in Appendix 6 of IRC:78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the type of material, the extent of backfill, its laying and compaction etc. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of **Table-II**.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in **Clause 2502** of MoST Specifications for Roads and Bridge Works (IV Revision) unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure. All work shall be done under the supervision of safety officers for safe work and work Inspected by Quality Control Employer's Representative and Approved By the Employer's Representative in Charge for work execution .

Construction of Embankment over Ground Incapable of Supporting Construction Equipment:

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Employer's Representative. The Contractor, if so desired by

him, may also use suitable Geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Employer's Representative, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 5A.3.19.4.

Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Employer's Representative. Acceptable granular material shall consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

Earthwork for high embankment

In the case of high embankments, the Contractor shall normally use the material from the specified borrow area. In case he desires to use different material for his own convenience, he shall have to carry out necessary soil investigations and redesign the high embankment at his own cost. The Contractor shall then furnish the soil test data and design of high embankment for approval of the Employer's Representative, who reserve the right to accept or reject it.

If necessary, stage construction of fills and any controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas with approved material for the periods specified in the Contract. If settlement of surcharged fill results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the Contractor shall remove the unacceptable material and dispose it as per direction of the Employer's Representative. He shall then bring the resultant level up to formation level with acceptable material.

Settlement period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for Abutment, Wingwall, retaining wall, Footings, etc., or Driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the Contract or as directed by the Employer's Representative.

5A.3.20.7 Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and / or subgrade without the prior permission of the Employer's Representative. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Employer's Representative.

5A.3.20.8 Surface Finish and Quality Control of Work

The surface finish of construction of subgrade shall conform to the requirements of Clause 902 of MoST Specifications for Roads and Bridge Works (IV Revision). Control on the quality of materials and works

shall be exercised in accordance with Clause 903 of MoST Specifications for Roads and Bridge Works (IV Revision).

5A.3.20.9 Subgrade Strength

It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on undisturbed samples cut out from the compacted subgrade in CBR mold fitted with cutting shoe or on remolded samples, compacted to the field density at the field moisture content.

5A.3.20.10 Measurements

Earth embankment/subgrade construction shall be measured separately by taking cross sections at intervals in the original position before the work starts and after its completion and computing the volumes of earthwork in cubic metres by the method of average end areas.

The measurement of fill material from borrow areas shall be the difference between the net quantities of compacted fill and the net quantities of suitable material brought from roadway and drainage excavation. For this purpose, it shall be assumed that one cum. of suitable material brought to site from road and drainage excavation forms one cum. of compacted fill and all bulking or shrinkage shall be ignored.

Construction of embankment under water shall be measured in cum.

Construction of high embankment with specified material and in specified manner shall be measured in cum.

Stripping including storing and reapplication of topsoil shall be measured in cum. Work involving loosening and recompacting of ground supporting embankment / subgrade shall be measured in cum.

Removal of unsuitable material at embankment / subgrade foundation and replacement with suitable material shall be measured in cum.

Scarifying existing granular / bituminous road surface shall be measured in square metres.

Dismantling and removal of existing cement concrete pavement shall be measured vide Clause 202.6 of MoST Specifications for Roads and Bridge Works (IV Revision).

Filter medium and backfill material behind abutments, wing walls and other retaining structures shall be measured as finished work in position in cum.

5A.3.20.11 Rates

The Contract unit rates for the items of embankment and subgrade construction shall be payment in full for carrying out the required operations including full compensation for:

Cost of arrangement of land as a source of supply of material of required quantity for construction unless provided otherwise in the Contract;

Setting out;

Compacting ground supporting embankment / subgrade except where removal and replacement of unsuitable material or loosening and recompacting is involved;

Scarifying or cutting continuous horizontal benches 300 mm wide on side slopes of existing embankment and subgrade as applicable;

Cost of watering or drying of material in borrow areas and / or embankment and subgrade during construction as required.

Spreading in layers bringing to appropriate moisture content and compacting to Specification requirements;

Shaping and dressing top and slopes of the embankment and subgrade including rounding of corners;

Restricted working at sites of structures;

Working on narrow width of embankment and subgrade;

Excavation in all soils from borrow pits / designated borrow areas including clearing and grubbing and transporting the material to embankment and subgrade site with all lifts and leads unless otherwise provided for in the Contract;

All labour, materials, tools, equipment and incidentals necessary to complete the work to the Specifications;

Dewatering; and Keeping the embankment / completed formation free of water as per Clause 5A.5.25.

In case the Contract unit rate specified is not inclusive of all leads, the unit rate for transporting material beyond the initial lead, as specified in the Contract for construction of embankment and subgrade shall be inclusive of full compensation for all labour, equipment, tools and incidentals necessary on account of the additional haul or transportation involved beyond the specified initial lead.

The Contract unit rate for the items of stripping and storing topsoil and of reapplication of topsoil shall include full compensation for all the necessary operations including all lifts, but leads up to 1000 m.

The contract unit rate for loosening and recompacting the loosened materials at subgrade shall include full compensation for loosening to the specified depth, including breaking clods, spreading in layers, watering where necessary and compacting to the requirements.

The Contract unit rate for scarifying existing granular / bituminous road surface shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. This will also comprise of handling, salvaging, stacking and disposing of the dismantled materials within all lifts and up to a lead of 1000 m or as otherwise specified.

Clause 202.7 of MoST Specifications for Roads and Bridge Works (IV Revision) shall apply as regards Contract unit rate for dismantling and removal of existing cement concrete pavement.

The Contract unit rate for providing and laying filters material behind abutments shall be payment in full for carrying out the required operations including all materials, labour, tools, equipment and incidentals to complete the work to Specifications.

Clause 5A.3.19.5 shall apply as regards Contract unit rate for construction of embankment under water.

Clause 5A.3.19.5 shall apply as regards Contract unit rate for construction of high embankment. It shall include cost of instrumentation, its monitoring and settlement period, where specified in the Contract or directed by the Engineer.

5A.3.21. Soil Erosion and Sedimentation Control**5A.3.21.1 Scope**

This work shall consist of measures as shown on Approved plans or as directed by the Employer's Representative to control soil erosion, sedimentation and water pollution, through use of berms, dikes, sediment basins, fibre mats, mulches, grasses, slope drains, and other devices.

5A.3.21.2 Materials

All materials shall meet commercial grade standards and approved by Quality Control Employer's Representative and shall be approved by the Employer's Representative before being used in the work.

5A.3.21.3 Construction Operations

Prior to the start of any Construction, the Contractor shall submit to the Employer's Representative for approval his schedule plan for carrying out temporary and permanent erosion / sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment / subgrade construction, bridges and other structures across water course, pavement courses and shoulders and all safety precautionary actions approved by Safety Officers. He shall also submit for approval his proposed method of erosion / sedimentation control on service road and borrow pits and his plan for disposal of waste materials. Work shall not be started until the erosion / sedimentation control schedules and methods of operations for the applicable construction have been approved by the Employer's Representative.

The surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations shall be limited to the extent practicable. The Contractor may be directed to provide immediate permanent or temporary erosion and sedimentation control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of nearby streams or other water courses, lakes, reservoirs etc. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation. Cut and fill slopes shall be seeded and turfed as required on the Approved Plans and Drawings .

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion / sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the Project.

Where erosion or sedimentation is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion or sedimentation control features can follow immediately thereafter if the project conditions permit; otherwise temporary erosion or sedimentation control measure may be required between successive construction stages. Under no conditions shall a large surface area of erodible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the Employer's Representative.

The Employer's Representative may limit the area of excavation, borrow and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading,

mulching, seeding and other such permanent erosion, sedimentation and pollution control measures, in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion / sedimentation control measures shall be taken immediately to the extent feasible and justified.

In the event temporary erosion, sedimentation and pollution control measures become necessary due to the Contractor's negligence, carelessness or failure to install permanent controls as a part of the work as scheduled or ordered by the Employer's Representative, these shall be carried out at the Contractor's own risk and expenses. Temporary erosion, sedimentation and pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the Employer's Representative.

Temporary erosion, sedimentation and pollution control may include construction work outside the right-of-way where such work is necessary as result of road construction such as borrow pit operations, Service roads and Equipment storage sites.

The temporary erosion, sedimentation and pollution control features installed by the Contractor shall be acceptably maintained by him till these are needed, unless otherwise agreed by the Employer's Representative.

5A.3.21.4 Measurements

The soil erosion, sedimentation and pollution control works will be measured in terms of units specified in the Bill of Quantities for the respective items.

5A.3.21.5 Rates

The contract unit rate for different items of soil erosion, sedimentation and pollution control works shall be payment in full for carrying out all required operations including full compensation for all labour, tools, equipment and incidents to complete the works to the specifications.

5A.3.22. Turfing with Sods

5A.3.22.1 Scope

This work shall consist of furnishing and laying of the live sod of perennial turf forming grass on embankment slopes, verges (earthen shoulders) or other locations shown on the Drawings or as directed by the Employer's Representative. Unless otherwise specified, the work shall be taken up as soon as possible following construction of the embankment, provided the season is favourable for establishment of the sod.

5A.3.22.2 Materials

The Sods shall consist of dense, well-rooted growth of permanent and desirable grasses, indigenous to the locality where it is to be use and shall be practically free from weeds or other undesirable matter. At the time the Sod is cut, the grass on the sod shall have a length of approximately 50 mm and the sod shall have to be free from debris.

Thickness of the sod shall be as uniform as possible, with some 50-80 mm or so of soil covering the grass roots depending on the nature of the sod, so that practically all the dense root system of the grasses is retained in the sod strip. The sods shall be cut in rectangular strips of uniform width, not less than about 250 mm X 300 mm in size but not so large that it is inconvenient to handle and transport these without damage. During wet weather, the sod shall be allowed to dry sufficiently to prevent rearing

during handling and during dry weather shall be watered before lifting to ensure its vitality and prevent the dropping of the soil in handling.

5A.3.22.3 Construction Operations for Turfing with Sods

Preparation of Earth Bed

The area to be sodded shall have been previously constructed to the required slope and cross section. Soil on the area shall be loosened, freed of all stones larger than 50 mm size, sticks, stumps and any undesirable foreign matter, and brought to a reasonably fine granular texture to a depth of not less than 25 mm for receiving the sod.

Where required, topsoil shall be spread over the slopes. Prior to placing the topsoil, the slopes shall be scarified to a depth which, after settlement, will provide the required nominal depth shown on the plans. Spreading shall not be done during and when the ground is excessively wet.

Following soil preparation and top soiling, where required, fertilizer and ground limestone when specified shall be spread uniformly at the rate indicated on the plans. After spreading, the materials are incorporated in the soil by discing or other means to the depths shown on the Approved Drawings and plans or as directed by the Employer's Representative Instructions at the Site .

Placing the sods

The prepared sod bed shall be moistened to the loosened depth, if not already sufficiently moist, and the sod shall be placed thereon within approximately 24 hours after the same had been cut. Each sod strip shall be laid edge to edge and such that the joints caused by abutting ends are staggered. Every strip, after it is snugly placed against the strips already in position, shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. All work shall be done by the Contractor by approved Specialist like Land scape architect and Approved Drawing

On side slopes steeper than 2 (horizontal) to 1 (vertical), the laying of sods shall be started from bottom upwards. At points where water may flow over a sodded area, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth placed over this followed by its through compaction.

Staking the sods

Where the side slope is 2 (horizontal) to 1 (vertical) or steeper and the distance along the slope is more than 2 m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000 mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods to be almost flush with them and all works shall be done by approved Method of statement and Procedures Approved by the Employer's Representative in charge .

Top dressing

After the sods have been laid in position, the surface shall be cleaned of loose sod, excess soil and other foreign material. Thereafter, a thin layer of topsoil shall be scattered over the surface of top dressing and the area thoroughly moistened by sprinkling with water.

Watering and maintenance

The sods shall be watered by the Contractor for a period of at least four weeks after laying. Watering shall be so done as to avoid any erosion and prevent damage to sodded areas by wheels of water tanks.

The Contractor shall erect necessary warning signs and barriers along with safety officer supervision

,and repair or replace sodded areas failing to show uniform growth of grass or damaged by his operations and shall otherwise maintain the sod at his cost until final acceptance.

5A.3.22.4 Measurement

Turfing with sods shall be measured as finished work in square metres.

5A.3.22.5 Rate

The Contract unit rate for turfing with sods shall mean payment in full for carrying out all the required operations explained above including compensation for:

Furnishing all the materials to be incorporated in the Works with all leads and lifts; and all labour, tools, equipment and incidental to complete the work in accordance with these Specifications.

5A.3.23. Seeding and Mulching

5A.3.23.1 Scope

This shall consist of preparing slopes, placing topsoil, furnishing all seeds, commercial or organic fertilizers and mulching materials, providing jute netting and placing and incorporation the same on embankment slopes or other locations designated by the Employer's Representative or shown in the Contract documents.

5A.3.23.2 Materials

Seeds

The seeds shall be approved quality and type suitable for the soil on which these are to be applied and shall have acceptable purity and germination to requirements set down by the Employer's Representative.

Fertilizer

This shall consist of standard commercial materials and conform to the grade specified. Organic manure shall be fully purified organic matter such as cow dung ,sheep goats etc .

Mulching materials

This shall consist of straw, hay wood shavings or sawdust and shall be delivered dry. They shall be reasonably free of weed seed and such foreign materials as may detract from their effectiveness as mulch or be injurious to the plant growth.

Topsoil

Topsoil shall not be obtained from an area known to have noxious weeds growing in it. If treated with herbicides or sterilents (disinfectants), it shall be got tested by appropriate agricultural authority or soil testing agent to determine the residual in the soil. Topsoil shall contain not less than 2 per cent and not more than 12 per cent organic matter.

Bituminous Emulsion

A suitable grade of bituminous cutback or emulsion used as a tie down for mulch shall be as described in the Contract document or as desired by the Employer's Representative. Emulsified bitumen shall not contain any solvent or diluting agent toxic to plant life.

Netting

Jute netting shall be undyed jute yarn woven into a uniform open weave with approximate 2.5 cm square openings. Geo-netting shall be made of uniformly extruded rectangular mesh having mesh opening of 2 cm x 2 cm. The colour may be black or green. It shall weigh not less than 3.8 kg per 1000 sq. m.

5A.3.23.3 Seeding Operations

Seed-bed Preparation

The area to be seeded shall be brought to the required slope as per approved Drawings and cross-section by filling, reshaping eroded areas and refinishing slopes, median etc. Topsoil shall be evenly spread over the specified areas to the depth shown on the plans, unless otherwise approved by the Employer's Representative. The seed-bed preparation shall consist of eliminating all live plants by suitable means using agricultural implements. All stones 150 mm in smallest dimension and larger shall be removed. The soil shall be excavated on the contour to a depth of 100 mm. All clods large than 25 mm in diameter shall be crushed and packed. Where necessary, water shall then be applied. All topsoil shall be compacted unless otherwise specified or approved by the Employer's Representative. Compaction shall be by slope compactor, cleated tractor or similar equipment and calibration records checked by safety Employer's Representative and approved by the Employer's Representative. Equipment shall be so designed and constructed as to produce a uniform rough textured surface ready for seeding and mulching and which will bond the topsoil to the underlying material. The entire area shall be covered by a minimum of 4 passes or 2 round trips of the roller or approved equipment.

Fertilizer application

Fertilizer to the required quantities shall be spread and thoroughly incorporated into the soil surface as a part of the seed-bed preparation and Progressive records shall be maintained for continuous maintenance and Periodically Inspected by Agriculturist .

Planting of seeds

All seeds shall be planted uniformly at the approved rate. Immediately after sowing, the area shall be raked, dragged or otherwise treated so as to cover the seeds to a depth of 6 mm. The operation of seed sowing shall not be performed when the ground is muddy or when the soil or weather conditions would otherwise prevent proper soil preparation and subsequent operations.

Soil Moisture and Watering requirements

Soil moisture shall exist throughout the zone from 25 mm to at least 125 mm below the surface at the time of planting. Watering off the seeded areas shall be carried out at regular periods as determined by the Employer's Representative.

Mulching, Applying Bituminous Emulsion and Jute Netting / Geo netting

Within 24 hours of seeding, mulching material mixed with organic manure shall be placed so as to form a continuous, unbroken cover of approximate uniform thickness of 25 mm using an acceptable mechanical blower. Mulching material shall be held in place and made resistant to being blown away by suitable means approved by the Employer's Representative. When called for in the Contract documents, mulch material shall be anchored in place with bituminous emulsion applied at the rate of 2300 litres per hectare. Any mulch disturbed or displaced following application shall be removed, reseeded and re mulched as specified. Jute netting / Geo netting shall be unrolled and placed parallel to the flow of water immediately following the bringing, to finished grade, the area specified on the plans or the placing of seed and fertilizer. Where more than one strip is required to cover the given areas, they

shall overlap a minimum of 100 mm. Jute netting / Geo netting shall be held in place by approved wire staples, pins, spikes or wooden stakes driven vertically into the soil

Maintenance

The Contractor shall maintain all seeded and mulched areas until final handing over and acceptance by the Client . Maintenance shall include protection of traffic by approved warning signs or barricades and repairing any areas damaged following the seeding and mulching operations. If mulched areas become damaged, the area shall be reshaped and then seeded and mulched again as originally specified.

Measurement for payment

Seeding and mulching shall be measured as finished work in square metres.

Rate

The Contract unit rate for seeding and mulching shall be payment in full for carrying out all the required operations including full compensation for all materials, labour, tools and incidentals.

Preparation and Surface Treatment of Formation

Preparation and surface treatment of the formation, that is top of the subgrade, shall be carried out only after completion of any specified subgrade drainage and unless otherwise agreed by the Employer's Representative, immediately prior to laying the sub-base or the road base where no sub-base is required. The sequence of operations shall be as follows:

All surfaces below carriageway, lay byes, footways and hard shoulders shall, after reinstatement of any soft areas to the required Specifications be well cleaned and freed of mud and slurry and any other Debris

The surface shall be compacted by 4 passes of a smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

The trimmed formation shall be rolled by one pass of smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

Where the completed formation is not immediately covered with sub base or road base material, its moisture content shall be maintained to prevent cracking in the formation by suitable measures as approved by the Employer's Representative. The entire work of surface treatment of formation shall be deemed as incidental to the work of sub-base / base course to be provided on the subgrade and as such no extra payment shall be made for the same.

Works to be Kept Free of Water

The Contractor shall arrange for the rapid dispersal of water collected / accumulated on the earthwork or completed formation during construction or on the existing roadway or which enters the earthwork or any other item of work from any source, and where practicable, the water shall be discharged into the permanent outfall of the drainage system. The arrangement shall be made in respect of all earthwork including excavation for Pipe Trenches, Foundations or cuttings.

The Contractor shall provide, where necessary, temporary water courses, ditches, drains, pumping or other means for maintaining the earthwork free from water. Such provisions shall include carrying out the work of forming the cut sections and embankments in such manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

The works involved in keeping the earthwork or any other item of works free of water shall be deemed as incidental to the respective item of work and as such no separate payment shall be made for the same.

5A.3.24. Site Filling

5A.3.24.1 Sand fill

Sandy fill shall be deposited to bring the grade level to the desired elevation after compaction of fill. Sandy fill shall be carried out in one of the following methods as detailed in the drawings:

Compaction of sandy 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.

Sandy fill shall be compacted where so specified by 12 tonne vibrating rollers. The fill material shall be compacted to the required density.

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.

5A.3.24.2 Soil fill

Approved soil fill consisting of ordinary soil, murram, 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 above.

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

5A.3.24.3 Measurement

Measurement shall be made on the basis of Clause 5A.3.13

5A.4 - CONCRETE AND ALLIED WORKS

5A.4.1. Applicable Codes

5A.4.1.1 Materials

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

5A.4.1.2 Material Testing

- 1) IS: 650 Specification for standard sand for testing of cement
- 2) IS: 2430 Methods for sampling of aggregates for concrete.
- 3) IS.2386 Methods of test for aggregates for concrete (Parts 1 to 8)
- 4) IS: 3025 Methods of sampling and test (physical and chemical) for water used in industry.
- 5) IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
- 6) IS: 4032 Method chemical analysis of hydraulic cement.
- 7) IS: 6925-1973 Methods of test for determination of water-soluble chlorides in concrete admixtures.

5A.4.1.3 Material Storage

- 1) IS: 4082 Recommendations on stacking and storing of construction materials at site

5A.4.1.4 Concrete Mix Design

- 1) IS: 10262 Recommended guidelines for concrete mix design.

- 2) SP: 23 (S&T) Handbook on Concrete Mixes.

5A.4.1.5 Concrete Testing

- 1) IS: 516 Method of test for strength of concrete.
- 2) IS: 1199 Method of sampling and analysis of concrete.
- 3) IS: 2770 Methods of testing bond in reinforced concrete.
- 4) IS: 8142 Method of test for determining setting time of concrete by resistance.
- 5) IS: 9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
- 6) IS: 9284 Method of test for abrasion resistance of concrete.

5A.4.1.6 Equipment

- 1) IS: 1791 Specification for batch type concrete mixers.
- 2) IS: 2438 Specification for roller pan mixer.
- 3) IS: 2505 General Requirements for concrete vibrators: Immersion type.
- 4) IS: 2506 General Requirements for screed board concrete vibrators.
- 5) IS: 2514 Specification for concrete vibrating tables.
- 6) IS: 2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).
- 7) IS: 2750 Specification for steel scaffoldings.
- 8) IS: 4925 Specification for concrete batching and mixing plant.
- 9) IS: 4656 Specification for form vibrators for concrete.
- 10) IS: 5892 Specification for concrete transit mixer and agitator.
- 11) IS: 7242 Specification for concrete spreaders.
- 12) IS: 7251 Specification for concrete finishers.
- 13) IS: 11993 Code of practice for use of screed board concrete vibrators.

5A.4.1.7 Codes of Practice

- 1) IS: 456 Code of practice for plain and reinforced concrete.
- 2) IS: 457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
- 3) IS: 2204 Code of practice for construction of reinforced concrete shell roof.
- 4) IS: 2210- 1988 Criteria for the design of reinforced concrete shell structures and folded plates.
- 5) IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement.

- 6) IS: 2571 Code of practice for laying in-situ cement concrete flooring.
- 7) IS: 2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
- 8) IS: 3370 (Parts 1 to 4) Code of practice for concrete structures for storage of liquids
- 9) IS: 3414 Code of practice for design and installation of joints in buildings.
- 10) IS: 3558 Code of practice for use of immersion vibrators for consolidating concrete.
- 11) IS: 3935 Code of practice for composite construction.
- 12) IS: 4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)
- 13) IS: 4326 Code of practice for earthquake resistant design and construction of building.
- 14) IS: 5525 Recommendation for detailing of reinforcement in reinforced concrete works.
- 15) IS: 7861 Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.
- 16) IS: 9417 Specification for welding cold worked bars for reinforced concrete construction.

5A.4.1.8 Construction Safety

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

5A.4.2. General

The Employer's Representative in charge and the Quality Control 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 any of his responsibilities. All materials which do not conform to the Specifications shall be rejected with a NCR (Non Confirmation report).

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.

5A.4.3. Materials

5A.4.3.1 Cement

Unless otherwise specified in the Specification or called for by the Employer's Representative, cement shall be ordinary Portland cement (OPC-43 grade) Bags /Sulphate resistant cement (SRC)/ Alkali Resistant cement conforming to IS: 8112/ IS 12330 respectively unless specifically defined. The use of bulk cement will be permitted only with the approval of the Employer's Representative. Changing of brands, type or grade of cement within the same structure should be avoided - unless otherwise it is technically approved by the employer's representative.

However, cement for all submerged works under sea water shall be Sulphate and chloride resisting Portland cement conforming to BS-4027 or as per IS 12330 unless specifically defined. The use of bulk cement will be permitted only with the approval of the Employer's Representative. Changing of brands or type of cement within the same structure should be avoided as far as possible. Sample shall be tested at approved Laboratory at Contractor's cost from each lot of cement delivered at site.

Employer will not supply cement. It will be the responsibility of the Contractor to ensure supply of adequate quantity, proper storage and complete protection from dampness, contamination and minimize caking and false set. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls, and insulated from the floor to avoid contact with moisture from the ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. Not more than 12 bags shall be stacked in any tier. The Employer's Representative shall approve the storage arrangement. Consignments cement shall be stored as received and shall be consumed in the order of their delivery.

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

5A.4.3.2 Aggregates (General)

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

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

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

All fine and coarse aggregates proposed for use in the Works shall be subject to the Employer's Representative's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Employer's Representative.

Aggregates shall, except as noted above, consist of natural sands, manufactured Quarry Sand-M-Sand, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durable against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength shall such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on concrete specified later.

i) Sampling and Testing

Samples of the aggregates for mix design and determination of suitability shall be taken under the supervision of Employer's Representative and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests which have been made on proposed aggregates and on

concrete made from this source of aggregates shall be furnished to Employer's Representative in advance of the work for use in determining aggregate suitability. The costs of all such tests, sampling, etc., shall be borne by Contractor.

ii) Storage of Aggregates

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregates from bins or stockpiles. Coarse aggregate shall be piled in layers not exceeding 1.20 meters in height to prevent coning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after remixing may be accepted, if subsequent tests demonstrate conformance with required gradation.

iii) Specific Gravity

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

Fine Aggregate

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

a) Machine-made Sand – M-Sand

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

b) Screening and Washing

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

c) Foreign Material Limitations

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

Table 5.1			
		Percent by weight	
		Uncrushed	Crushed
i)	Material finer than 75 micron I.S sieve	3.00	15.00
ii)	Shale	1.00	—
iii)	Coal and lignite	1.00	1.00

iv)	Clay lumps	1.00	1.00
v)	Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) and (iv) for Crushed sand	5.00	2.00

d) Gradation

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

Table 5.2				
I.S. Sieve Designation	Percentage Passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

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

e) Fineness Modulus

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

Coarse Aggregate

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

a) Screening and Washing

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

b) Grading

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

I.S. Sieve Designation	Table 5.3								
	Percentage passing for single sized aggregate of nominal size					Percentage passing for Graded aggregate of nominal size			
	40 mm	20mm	16mm	12.5mm	10mm	40mm	20mm	16mm	12.5mm
63 mm	100	-	-	-	-	100	-	-	-
40 mm	85-100	100	-	-	-	95-100	100	-	-
20 mm	0-20	85-100	100	-	-	30-70	95-100	100	-
16 mm	-	-	85-100	100	-	-	-	90-100	-
12.5 mm	-	-	-	85-100	100	-	-	-	90-100
10 mm	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm	-	-	-	-	0-5	-	-	-	-

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

c) Foreign Material Limitations

The percentage of deleterious substances in the aggregate delivered to the mixer shall not exceed the following or refer Is code 383 -1970:

S.N.	Foreign Material	Percent by weight	
		Uncrushed	Crushed
i)	Material finer than 75 micron I.S Sieve	3.00	3.00
ii)	Coal and lignite	1.00	1.00
iii)	Clay lumps	1.00	1.00
iv)	Soft fragments	3.00	—
v)	Total of all the above substances	5.00	5.00

5A.4.3.3 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.

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

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

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

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

- (a) To neutralize 200 ml, sample of water, using Phenolphthalein as indicator, it should not require more than 2 ml. of 0.1 Normal NaOH. The details of test shall be as given in I.S: 3025.
- (b) To neutralize 200-ml. sample of water, using methyl orange, as an indicator should not require more than 10 ml. of 0.1 Normal HCL. The details of test shall be as given in I.S: 3025.
- (c) Percentage of solids, when tested in accordance with the method indicated below, shall not exceed the following:

Solids	Percent	Method of Test
		(Ref. to Cause No. In IS :3025)
Organic	0.02	10 and 11 (organic solids = total solids minus ignited residue)
Inorganic	0.30	11 (ignited residue)
Sulphates (as SO ₄)	0.05	20
Alkali Chloride (As Cl)	0.20	24
Suspended matter	0.20	12

5A.4.3.4 ReinforcementGeneral

In general, reinforcement for buildings and sewage treatment units shall be HYSD-CRS (Corrosion Resistant Steel) with epoxy coating of Grade Fe 500. All physical and chemical properties of this Fe 500 grade steel shall conform to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566 as shown or specified on the drawing.

The CRS (corrosion resistant steel) index shall be at least 1.35 when tested for Salt Spray test as per "ASTM B 117 – 2009 test procedure for 120 hours when compared with the Fe 500 normal reinforcement bars and with same bar diameter. Test results have to be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 Metric Tons.

Reinforcement bars produced using iron ore as the basic raw material only will be accepted. The manufacturer of Reinforcement bars must fall into the category of primary steel producer as defined by Ministry of Steel, Government of India.

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

Supply of Reinforcing Bars

Steel reinforcement, such as M.S. bars high yield strength deformed bars etc. required for the works shall be procured by Contractor. The Contractor shall arrange for transport, loading, unloading and storage at the work sites. The Contractor should plan the procurement of steel in such a way that at least required quantity of steel of specified sizes is available at site for 3 months period. Steel brought on site shall be stored in a proper manner as approved by the Employer's Representative so as to avoid distortion, deterioration and corrosion. The Contractor shall maintain proper registers for the steel account, showing the steel received at site, steel used, and the balance stock on site, to the entire satisfaction of the Employer's Representative.

Storage

The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber sleepers or the like. If the reinforcing rods have to be stored for a long duration, they shall be coated with cement wash before stacking and/ or be kept under cover or stored as directed by the Employer's Representative. Fabricated reinforcement shall be carefully stored to prevent damage, distortion corrosion and deterioration.

Quality

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

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

Representative, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

Laps

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

Bending

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

All bars shall be accurately bent according to the sizes and shapes shown on the approved details working drawings/bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and rebent in a manner that will injure the material, bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25mm in diameter which may be bent hot if specifically approved by the Employer's Representative. Bars which depend for their strength on cold working, shall not be bent hot. Bars bent hot shall not be treated beyond cherry red colour (nor exceeding 845°C) and after bending shall not be allowed to cool slowly without quenching.

Bars incorrectly bent shall be used only if the means used for straightening and rebending be such as shall not, in the opinion of the Employer's Representative, injure the material. No reinforcement shall be bent when in position the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those require by design shall not be used.

Fixing

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

5A.4.3.5 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. 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.

5A.4.4. Wastage

Wastage allowance for cement and steel and higher rolling margin for steel shall be considered in the item rate and no extra payment shall become payable to the Contractor on any account unless specified at Site by the Employer's Representative due to valid reasons.

5A.4.5. 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 / steel and when directed by the Employer's Representative samples shall also be got tested by the Contractor in a laboratory approved by the Employer's Representative at no extra cost to Employer. 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 the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

5A.4.6. Storing of Materials

All materials shall be stored or stacked or arranged in a well-defined or specified or approved manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS: 4082 safety code 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 if it gets deteriorated, the material shall be rejected by the Quality Employer's Representative . 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 Quality Control Employer's Representative / Employer's Representative in charge . 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 organic matter or 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 water tanks without any 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.

5A.4.7. Concrete

5A.4.7.1 General

Concrete grade shall be as designated on the general instructions in the approved drawings. 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 M10 and M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX

CONCRETE. The grade of Concrete to be adopted for the exposed condition as per IS:456-2000 (or as per latest version).

The grades of concrete to be used are noted on the drawings. In addition, the following table shall apply unless specified otherwise.

Structure	Grade of Concrete	Max. Aggregate Size
1. All Reservoir works / liquid /Sea water / sewage retaining structures / water tanks / intake structures / box culverts, lift walls and for Piles etc.	M35	20 mm / 25mm (maximum size)
2. Pumping Station and other General Building		
(a) For foundation raft, counterweight blocks for crane	M30	40 mm
(b) For walls, columns, floor beams, circular floor slab	M30	20 mm
(c) For beams, slabs etc.	M30	20 mm
3. Valve chambers and pipe trenches		
(a) For foundation raft	M30M30M30	40 mm
(b) Walls, columns		20 mm
(c) For slabs, beams, etc.		20 mm
4. Anchor blocks on pipeline, base slab of storm water drain	M20	40 mm
5. Saddles	M20	20 mm
6. Pipeline embankment, grade slab, ramps, footings under walls, SW drain coping etc.	M20	20 mm
7. Causeway	M20	20 mm

5A.4.7.2 Design Mix Concrete

Mix Design & Testing

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and 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 be 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 watertight 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
M20	315
M25	360
M30	375

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the Contractor in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor unless specified in the Contract for special mix design .

The Contractor shall submit details of the source of all materials 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 prior notice or 48 hours' notice of such trials to enable the Employer's Representative's Representative to attend. For each trial mix at the approved Concrete Plant, three separate batches of concrete shall be made by the Contractor and will be tested as per IS 516 code of testing and also at 28 days all in accordance with IS: 516 under the supervision of Quality Control Employer's Representative . Such trial mixes shall not be the first batch through the plant in any one sequence of concrete production. 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, only medium graded fine aggregate shall be used

A trial mix design will be approved by the Employer's Representative with respect to strength if the average compressive strength of the nine cubes so tested is more than the target mean strength appropriate to the grade of concrete.

For concrete of Grade 30 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 at his own cost. 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 as follows :

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 Foundation	75	40
Building columns	100	40
Pavements	50	40
Heavy mass construction	50	40

Note: All concreting done for water retaining structures shall have a minimum slump value of 60 mm and maximum of 100 mm for workability during concreting

Batching & Mixing of Concrete

It is expected that batching plants with boom pump of minimum 200 m³ capacity and pumps of minimum 50 m Boom length for placing concrete shall be used and Additional concrete mixers with boom pump (Putzmeister) Nos can be used based on the site requirement . Proportions of aggregates and cement, as decided 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.

5A.4.8. 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, using whole bags of cement.

5A.4.9. 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, waffle moulds 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 prior to commencement of work. and the type or method of Form work shall be specified for example either Doka or PERI, or Conventional Methods.,

Formwork shall be designed to fulfill the following requirements:

- (a) 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.
- (b) Made of suitable materials.
- (c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- (d) 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.
- (e) Capable of easily striking without shock, disturbance or damage to the concrete.
- (f) Soffit forms capable of imparting a camber if required.
- (g) Soffit forms and supports capable of being left in position if required.
- (h) 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 used with well-seasoned quality, 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 at no extra cost.

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-site 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. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete 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, except where specified in the approved drawings either in detail drawings or shop drawings .

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 as 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 (embedment's / 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 at Contractor's cost if any rejected by the Quality Control Employer's Representative.

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

1. Development of adequate concrete strength;
2. Permissible deflection at time of striking form work;
3. Curing procedure employed - its efficiency and effectiveness;
4. Subsequent surface treatment to be done;

5. Prevention of thermal cracking at re-entrant angles;
6. Ambient temperatures; and
7. 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.

5A.4.10. 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 by mechanical Bar Bending Machines and few small steel by Manual according to the sizes and shapes shown on the Approved drawings / schedules or as directed by the Employer's Representative.

Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Employer's Representative.

Reinforcement shall be always free from corrosion and inspected and Approved by Quality Control Employer's Representative and then accurately fixed and maintained firmly in the correct position and use of blocks, spacers, chairs, binding wire etc. shall be made 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 or thickness approved by the Quality Control Engineer and shall be 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.

Substitution of reinforcement, laps / splices not shown on drawing shall be subject to Employer's Representative's approval. All work shall be done to the Employer's Representative Satisfaction and if any changes shall be done as per w Site Instructions and Records shall be maintained by contractor for future Payment .

5A.4.11. Tolerances

Tolerance is a specified permissible variation from lines, grade or dimensions given in Approved drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS:456 unless specified otherwise.

5A.4.11.1 Tolerances for R.C. Buildings

As per National building Code can be referred for Tolerance and can be followed by the Contractor or as per Site Employer's Representative Instruction and Not Limited to the below details .

Variation from the Plumb

- (i) In the lines and surfaces of columns, piers, walls and in arises 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 | - | 5 mm |
| In 10 m or more | - | 10 mm |

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

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

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

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

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	-	5 mm
Plus	-	10 mm

Footings

- (i) Variation in dimension in plan
- | | | |
|-------|---|-------|
| Minus | - | 5 mm |
| Plus | - | 50 mm |
- (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 50 mm |
|-------|---|---|

Variation in steps

- (i) In a flight of stairs

Rise - 3 mm

Tread - 5 mm

(ii) In consecutive steps

Rise - 1.5 mm

Tread - 3.0 mm

5A.4.11.2 Tolerances in other structures

All structures

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

In 5 m - 10 mm

In 10 m or more - 15 mm

(ii) Variations of dimensions to individual structure features from established positions

In 20 m or more - 25 mm

In buried construction - 50 mm

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

In 2.5 m - not more than 10 mm

In 5 m - not more than 15 mm

In 10 m or more - less than or equal to 25 mm

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 2.5 m - maximum 5 mm

In 7.5 m or more - maximum 10 mm

In buried construction- Twice the above value.

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

Minus - 5 mm

Plus - 10 mm

(vi) Variation in the thickness of slabs, walls, arch sections and similar members

Minus - 5 mm

Plus - 10 mm

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

(i) Variation of dimension in plan

Minus - 10 mm

Plus - 50 mm

(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.

5A.4.11.3 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 28 mm dia : maximum 3 mm in all directions
- for bolts 32 mm dia and above : 3 mm in all directions
- (iii) Embedded parts : 5 mm in all directions

5A.4.11.4 Tolerances in Formwork:

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

(i)	Deviation from specified dimensions of cross section of columns and beams	- 6 mm + 12 mm
(ii)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels)	
	- Dimension in plan	- 12 mm + 50 mm
	- Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
	- Thickness	± 0.05 times the specified thickness

5A.4.12. Preparation Prior to Concrete Placement

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

pockets, etc. provided and all works shall be inspected and approved by the Quality Control Employer's Representative and the Employer's Representative in charge

All arrangements-formwork, equipment and proposed procedure, shall be approved by the Employer's Representative. Contractor shall maintain separate Pour Card for each pour as per the format enclosed.

5A.4.13. 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 shall not exceed the minimum Initial setting time of cement concrete and will prevent segregation, loss of any ingredients or ingress of foreign matter or water. All prior arrangements shall be made for continuous concrete delivery and all pour shall be maximum monolithic, without any time delay and . All the pour shall be approved by the Quality Control Employer's Representative and works shall be checked and approved by the Employer's Representative in charge.

In all cases concrete shall be poured as nearly as practicable directly in its final position without any deviation of the required shape . 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 so as to avoid maximum wastage and spillage and avoid removal of wastage after pour as stipulated in clause 5A.4.8.

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 pour can be controlled by Boom Pump with remote control by the pump operator 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 steps and get all approvals from the Quality control Employer's Representative and Site Employer's Representative before and after pouring the Concrete:

- a) Continuously between construction joints and pre- determined abutments.
- b) Without disturbance to forms or reinforcement.
- c) 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.
- d) Without dropping in a manner that could cause segregation or shock.
- e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes or Boom Pump with sufficient length .
- f) Do not place if the workability is such that full compaction cannot be achieved.
- g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide adequate sheeting or polythene sheet or as per site Employer's Representative instruction based on site condition any protection boards or ply woods later can be removed if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
- h) If placed directly onto hardcore or any other porous material, dampen or sufficiently wet by pouring adequate water or cement mortar to get good bonding and also for the surface to reduce loss of water from the concrete.
- i) Ensure that there is no damage or displacement to sheet membranes.
- j) 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 for the Structures that are approved for pouring with

approved and Periodically calibrated vibrating Machine or 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 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 setting time.

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 with admixtures or any approved chemicals or five distinct classes of chemical admixtures: air-entraining, water-reducing, retarding, accelerating, and plasticizers (superplasticizers). (for eg FOSROC) to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Also contractor shall note that the most common reasons for using chemical admixtures in a concrete mix are:-

- To increase workability without changing water content
- To reduce water content without changing workability
- To adjust setting time
- To reduce segregation and / or bleeding
- To accelerate the rate of early strength gain
- To improve pumpability
- To increase strength
- To improve potential durability and reduce permeability
- To reduce the total cost of the materials used in the concrete
- To compensate for certain poor aggregate grading / properties
- To depress the freezing point of water in concrete at very low temperatures (up to minus 30°C)
- To maintain adequate freezing and thawing resistance of concrete
- To inhibit alkali-aggregate reactions (AAR) .

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. Sufficient Cubes shall be taken for the Cube test or as directed by the Quality Control Employer's Representative and the Employer's Representative In charge.

5A.4.14. 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 by using approved admixture or Super Plasticizers to prevent or rectify shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

5A.4.15. Curing

Curing shall be done on the next day after 24 hours and after 3 hrs of pouring or if heavy rain immediately with polythene sheet and for high hot region protection shall start immediately after the compaction of the concrete to protect it from:

- a) Premature drying out, particularly by solar radiation and wind;
- b) Leaching out by rain and flowing water;
- c) Rapid cooling during the first few days after placing;
- d) High internal thermal gradients;
- e) Low temperature or frost;
- f) 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 jute cloth, canvas, hessian cloth 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. And curing shall be to the satisfaction of the Quality Control Employer's Representative and as per IS codes

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.

5A.4.16. Construction Joints and Keys

Construction joints will be as shown on the approved for construction 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 epoxy paint or cement slurry and encased in lean concrete as indicated on the approved 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. Roughening of the surface by chipping or hacking will not generally be approved. Before placing fresh concrete against a construction joint all loose material shall be removed with air blower or any approved equipment 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 approved cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well vibrated

or rammed against the old concrete work. Thereafter work shall proceed in the normal way or as per Site Instruction by the Employer's Representative in charge.

5A.4.17. Foundation Bedding

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

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

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

5A.4.18. Finishes

5A.4.18.1 General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good without any voids or defects or bulging or if 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 approved structure with the approved or specified 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. All the Structure will meet the Quality control requirement and Quality management Plan and finally shall have Confirmation report (CR).if Any NCR (Non Confirmation report)shall be rectified immediately

5A.4.18.2 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.

5A.4.18.3 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. (Blemish is any type of mark, spot, discoloration, or flaw that appears on the skin)

5A.4.18.4 Surface Finish Type F3

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. If any minor blemishes that might occur shall be rectified immediately to the satisfaction of the Quality control Employer's Representative by the Contractor.

5A.4.18.5 Unformed Surfaces

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

Definition and Explanation for U1,U2,U3 finishes.

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.

5A.4.18.6 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 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.

5A.4.19. 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 QUALITY Control Employer's Representative and Employer's Representative in charge who may permit patching of the defective areas or reject the concrete work by NCR (Non Confirmation Report).

All through holes for shuttering shall be filled for full depth with specially approved material 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 with approved bonding material agent 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 to be rectified shall be marked by Quality Control Employer's Representative and separated or isolated and

saturated with water for 24 hours before patching is done with ratio 1:5 cement and 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.

5A.4.20. 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.

5A.4.21. Hot Weather Requirements

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

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

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

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

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

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

5A.4.22. Placing Concrete Underwater

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

i) Method of Placement

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

ii) Discretion, Inspection and Approval

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

5A.4.23. Liquid Retaining Structures

The Contractor shall take special care for concrete for liquid retaining structures, underground structures, Water tanks , Reservoirs , etc tanks as listed in the Approved drawings , Overhead tanks , structures and those others specifically called for to guarantee the finish and water tightness. Special concrete as approved by Quality Control Employer's Representative shall be used for Liquid retaining Structures .

The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be leak proof and shall be hydro-tested for leakage by the Quality Control Employer's Representative .

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

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates in the Bill of Quantity.

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 Injection 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 at no extra cost to the Employer.

5A.4.24. Testing Concrete Structures for Leakage

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, as described below :

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.

In the case of structures whose external faces are buried and are not accessible for inspection necessary arrangements shall be made by the contractor to make access for Inspection for the Quality Control Employer's Representative for Visual Inspection and for Leakage testing for underground tanks, the structures shall be filled with water and after seven days the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Employer's Representative shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment / segment of the structure shall be hydro tested individually.

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.

5A.4.25. Optional Tests

If the Employer's Representative is not satisfied with the results of the tests under Clause 5A.4.5 or otherwise considers that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications 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. Contractor shall pay for these tests .

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 or core test by cutting and conduct tests on them or do ultrasonic testing or load testing of structure, if any Cube test may not satisfy the Quality Control Employer's Representative etc. The Employer's Representative also reserves the right to ask the Contractor to rectify or dismantle and re-do such unacceptable work, at no cost to the Employer by a NCR (Non Confirmation Report) and the Contractor shall redo or rectify and close the NCR with Compliance report.

If the structure is certified as failure or Rejected by Employer's Representative, the cost of the test and subsequent dismantling / reconstruction shall be borne by the Contractor.

The quoted unit rates / prices of concrete shall be deemed to provide for all tests mentioned above.

5A.4.26. Grouting**5A.4.26.1 Standard Grout**

Grout shall be provided as specified on the approved drawings. 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 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

5A.4.26.2 Non-Shrink Grout

Non – shrink grout where required shall be provided in strict accordance with the manufacturer's instructions / specifications on the drawings.

5A.4.27. 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.

5A.4.28. 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 and shall be approved by the Quality Control Employer's Representative after Inspection .

5A.4.29. Acceptance Criteria

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

- a) Properties of constituent materials;
- b) Characteristic compressive strength;
- c) Specified design mix proportions;
- d) Minimum cement content , Cement Freshness , Consistency .
- 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) Water tightness
 - 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.

5A.4.30. Mode of Measurement and Payment

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the Schedule of Quantities. No extra claim shall also be entertained due to change in the number, position and / or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding, Props other additional supports etc. All these factors should be taken into consideration while quoting the unit rates. Unless provided for in the Schedule of Quantities the rates shall also include fixing inserts in all concrete work, whenever required.

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 of a sqm and 0.010 cum where concrete is measured in cum. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly, the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slabs / beams.

The unit rate for all precast concrete structures and members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by Employer's Representative shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rate for reinforcement shall include all wastages, binding wires, chairs, spacer bars etc. for which no separate payment shall be made.

Where the formwork is paid for separately, it shall be very clearly understood that the payment for formwork is inclusive of formwork, shuttering, shoring, propping scaffolding etc. Only the net area of concrete formed (shuttered) shall be measured for payment.

5A.4.31. Water stops

5A.4.31.1 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. BIS IS 8543-4-1 : 1984(R2003) or as recommended by the Quality Control Employer's Representative in charge

- | | | |
|------------------------|---|--------------------------------|
| a) Tensile strength | : | 11.6 N/mm ² minimum |
| b) Ultimate elongation | : | 300% minimum |

- c) Tear resistance : 4.9 N/mm² minimum
- d) Stiffness in flexure : 2.46 N/mm² minimum
- e) Accelerated extraction
 - i) Tensile strength : 10.50 N/mm² minimum
 - ii) Ultimate elongation : 250% minimum
- (f) Effect of Alkali : 7 days
 - i) Weight increase : 0.10% maximum
 - ii) Weight decrease : 0.10% maximum
 - iii) Hardness change : ± 5 points
- (g) Effect of Alkali : 28 days
 - i) Weight increase : 0.40% maximum
 - ii) Weight decrease : 0.30% maximum
 - iii) Dimension change : $\pm 1\%$

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.

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.

5A.4.31.2 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. **Particular care shall also be taken to ensure that no honey-combing occurs because of the serrations / end grips.** 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.

5A.4.31.3 Measurement

Measurement shall be in running meters correct to two places of decimal. No separate payment shall be made for joints or intersection pieces.

5A.4.32. Preformed Fillers and Joint Sealing Compound**5A.4.32.1 Materials used as fillers for Expansion Joints / Construction joints.**

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 (Industrial bitumen). 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 15,000 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 (Shore A) : > 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 (Shore A) : > 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 (Shore A) : > 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 (Shore A) : > 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 (Shore A) : > 12

Transverse Movement Accommodation : $\pm 12.5\%$

Approved Sealants

The following approved sealants meet the above specifications.

Sealant Type A, B and C : (Fosroc) Thioflex 600 gun grade

Sealant Type D : Thioflex 600 pourable grade

Sealant Type E : (Fosroc) Colpor 200

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.

5A.4.32.2 Workmanship

The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment's. Contractor shall procure the strips of the desired thickness and width in lengths from approved manufacturer. 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 after approval from Employer's Representative in charge. 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 or displacing. 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 smooth 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 / plug 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 hydro 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 and as per quality Control Employer's Representatives Instruction. De-bonding strip shall be used in conjunction with the sealers as indicated on the Approved Drawings or Shop Drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to attack 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 IS 12118.

5A.4.32.3 Measurement

Measurement for the preformed joint filler shall be in sq.m correct to two places of decimal for the specified thickness as per items of work. Measurement for applying the bitumen coat to concrete/masonry surfaces shall be in sq.m correct to two places of decimal. Measurement for the joint sealing compound shall be in running metres correct to two places of decimal for the specified width and thickness as per the items of work. Measurement for the mild steel corner angle and plate shall be by weight as per the items of work.

5A.4.33. Concreting Records and Pour Card 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 Pour card log book and records shall contain notes and records of :

1. The names of the Contractor's Employer's Representative who are responsible for the different phases of the concrete work and also the names of their assistants.
2. The temperatures of that particular site atmospheric air, water, cement, aggregates, together with the air humidity and type of weather condition (rainy or sunny or windy, storm etc details).
3. Deliveries to the Site of concrete materials (quantity, brand of concrete, etc).
4. Inspections carried out like slump test, cube casting at site, tests performed, etc. and their results.
5. Time of commencement and completion of different parts of the concrete works for different structures and times of erection and striking of forms.
6. Quantity of cement, fine and coarse aggregate and admixture used for each section of work and the number and kind of test samples taken on these ingredients and water.

Concrete Pour Card					
Client :		Date :		Pour No. :	
Project :		Structure :			
Contractor :		Max. Aggregate Size / Slump :			
Drawing. No. :		Start / Completion Time : /			
Concrete Grade / Quantity : /		Mixing Time :			
Sl. No.	Item		Contractor's Rep. Sign	Engineer's Sign	Remarks
1.	Before Concreting	Centerlines Checked			Pour Authorized Site Engineer
2.		Formwork And Staging Checked for Accuracy, Strength & Finish			
3.		Reinforcement Checked			
4.		Cover To Reinforcement Checked			
5.		Verified Test Certificate For Cement / Steel	Yes / No	Yes / No	
6.		Adequacy Of Materials / Equipment For Pour	Yes / No	Yes / No	
7.		Embedded Part S	Civil		
		Checked	Mechanical		
		(Location & Plumb)	Electrical		
8.	Soffit(S) & Pour Top(T) Levels Checked Before (B) & After (A) Form Removal (Only Of Beams Of Over 10 M Span & Important Structure Like T.G. Etc.)		S(B) S(A)	T(B) T(A)	
9.	Construction Joints Location & Time (If Not As Per Drawing)				

10.	Cement Consumption In Kgs.		
11.	Number Of Cubes And Identification Marks		
12.	Test Cube Results (7 Days / 28 Days)		
13.	Concrete Condition On Form Removal	Very Good / Good/Fair / Poor	

Site-in-charge / Quality Control Employer's Representative – In- charge

Contractor Representative / Quality Control Employer's Representative

Notes : 1. Each item to be checked and signed by the respective Employer's Representatives (Both contractor and Consultant or Client Representative Employer's Representatives)

2. Items 8 to 13 (both inclusive) to be filled only by Employer's Representative.

3. Each pour to have separate cards, in triplicate one each for client, consultant & site office.

Under remarks indicate deviations from drawings & specifications, congestion in reinforcement if any, unusual occurrences, such as failure of equipment's, sinking of supports / props. Heavy rains affecting concreting, poor compaction, improper curing, other deficiencies, observations etc.

5A.5 - ROADS AND DRAINS

5A.5.1. Applicable Codes and Specifications

The following specifications, standards and codes are referred to in this part.

IS : 73 :	Specification for Paving Bitumen
IS : 215:	Specification for Road Tar
IS : 217:	Specification for Cutback Bitumen
IS : 454 :	Specification for Digboi type Cutback Bitumen
IS : 460:	Specification for Test sieves

(Parts 1 to 3)

IS : 1077 :	Common burnt clay building bricks - Specification
IS : 1124 :	Method of test for determination of water absorption, apparent specific gravity and porosity of building stones
IS : 1195 :	Specification for Bitumen Mastic for Flooring
IS : 1196 :	Code of Practice for Laying Bitumen Mastic Flooring
IS : 1834 :	Specification for Hot Applied Sealing Compounds for Joints in Concrete
IS : 2386 :	Methods of test for aggregates for concrete

(Parts 1 to 8)

IS : 2720 :	Method of Test for Soils
(Part 5)	Determination of Liquid and plastic limit
IS : 6241 :	Method of test for determination of stripping value of road aggregates.
IRC : 15 :	Standard Specification and code of practice for construction of Concrete Roads (Third Revision)
IRC : 16 :	Specification for priming of Base Course with Bituminous Primers (Prime and Tack coat).
IRC : 17 :	Tentative specification for Single Coat Bituminous Surface Dressing
IRC : 19 :	Standard specifications and code of practice for water bound macadam
IRC : 37 :	Guideline for design of Flexible Pavements (Second Revision)
IRC : 29 :	Specification for bituminous concrete (Asphaltic Concrete) for road pavement

Ministry of Surface Transport : Specifications for road and bridge works (Roads wing)

All earthworks for Roads , drains and Pavements shall be according to Specifications specified in the previous titles and elsewhere or as per Site Employer's Representatives Instructions .s.

5A.5.2. Materials**5A.5.2.1 General**

All materials shall be obtained from local sources and shall be subject to Employer's Representative's approval prior to use.

5A.5.2.2 Soling Stone

It shall be clean, sound, dense, hard, tough, durable stone of uniform quality free from unsound material, cracks, decay and weathering. Water absorption shall not be more than 5 percent. The stone shall be in the smallest dimension equal to thickness of the soling course specified with a tolerance of 25 mm. Soling Stone shall be sufficiently flat bedded. The height of the soling stone shall be equal to the specified thickness of soling. The length and breadth shall not exceed twice the specified thickness.

5A.5.2.3 Stone Aggregate / Metal

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt, salt, alkali, vegetable matter, adherent coatings, organic and other objectionable matter, and shall conform to the physical requirements given in Tables 5.1 or 5.2 hereunder, as applicable. Aggregate for bituminous wearing courses shall in addition have good hydrophobic properties i.e. capacity of retaining the film of bituminous material applied to the stone in all weather conditions and especially in wet conditions. Basalt, dolerite are good in this respect; granite, quartzite are comparatively poor.

Table 5.1: Physical Requirements of Coarse Aggregate for Water Bound Macadam (Sub Base/ Base Course)

S. No	Test	Requirements	Test Method
1.	Los Angeles Abrasion Value* Or Aggregate Impact Value*	50 percent (max.) 40 percent (max.)	IS:2386 (Part – IV) IS:2386 (Part – IV) Or IS:5640***
2.	Flakiness Index **	15 percent (max.)	IS:2386 (Part I)

(*) Aggregate may satisfy requirements of either of two tests.

(**) Requirements of flakiness index shall be enforced only in case of crushed broken stone.

(***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS: 5640.

Table – 5.2 Physical Requirements of Aggregates for Bituminous Wearing Course

S. No.	Test	Requirements	Test Method
1.	Los Angeles Abrasion Value* Or Aggregate Impact Value*	40 percent (max.) 30 percent (max.)	IS:2386 (Part – IV) IS:2386 (Part – IV)
2.	Flakiness Index **	35 percent (max.)	IS:2386 (Part I)

3.	Stripping Value	25 percent (max.)	IS:6241
4.	Water Absorption	2 percent (max.)	IS:2386 (Part-III)
5.	Soundness		
	Loss with Sodium Sulphate – 5 cycles	12 percent (max.)	IS:2386 (Part-V)
	Loss with Magnesium Sulphate – 5 cycles	18 percent (max.)	

(*) Aggregate may satisfy requirements of either of two tests

(**) Requirement of flakiness index shall be enforced only in case of crushed broken stone

The coarse aggregate for water bound Macadam shall conform to one of the gradings given in Table-5.3 below :

Table – 5.3 Grading Requirements of Coarse Aggregates For Water Bound Macadam

Grading No.	Size Range	Sieve Designation	Percent by Weight Passing the Sieve
1.	90mm to 45mm	125 mm 90 mm 75 mm 63 mm 40 mm 22.4 mm	100 90-100 50-80 25-60 0-15 0-5
2.	63mm to 45mm	90 mm 63 mm 53 mm 45 mm 22.4 mm	100 90-100 50 -80 0-15 0-5
3.	53mm to 22.4 mm	63 mm 53 mm 45 mm 37.5 mm 22.4 mm 11.2 mm	100 95-100 65-90 30-65 0-10 0-5

5A.5.2.4 Screenings for Water Bound Macadam

Screenings to fill voids in the coarse aggregate shall consist of the same materials as the coarse aggregate. However, where permitted, predominantly non-plastic material such as Murram or gravel (other than river borne material) may be used for this purpose provided liquid limit and plasticity index

of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

Screenings shall conform to the gradings set forth in Table – 5.4. Screenings of Type-A in Table-5.4 shall be used with coarse aggregate of grading 1 in Table – 5.3. Screenings of Type A or B, as approved, shall be used with coarse aggregates of grading 2. Type-B screenings shall be used with coarse aggregates of grading 3.

Table –5.4 Gradings For Screenings

Grading No.	Size Range	Sieve Designation	Percent by Weight Passing the Sieve
A	12.5 mm	12.5 mm	100
		10.0 mm	90-100
		4.75 mm	10-30
		150 micron	0-8
B	10 mm	10 mm	100
		4.75 mm	85-100
		150 micron	10-30

The use of screening shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites etc. as they are likely to get crushed to a certain extent under rollers.

5A.5.2.5 Binding Material

Binding material shall comprise of a suitable material, approved by Employer's Representative, have plasticity index (Definition ; Liquid Limit is defined as the water content at which the soil changes from liquid state to plastic state.) value of less than 6 as determined in accordance with IS : 2720 (Part - V)

Application of binding material may not be necessary, when the screenings used are of crushable type such as Murram or gravel.

5A.5.2.6 Murram / Kankar / Gravel / Sand

Murram shall contain low plasticity binder material mixed with hard granular particles such as sand and / or gravel. Murram shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall all be broken at the quarry and Murram delivered at site must pass in every direction through a 63 mm ring. Murram shall not contain more than 5% to 8% of fines passing a 75 micron sieve.

Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt.

Sand used for blinding the bituminous road surface, shall be coarse, sharp, gritty, clean, granular material. Material passing through 4.75 mm sieve and retained on 75 micron sieve shall only be used.

5A.5.2.7 Bituminous Materials

Bituminous materials shall conform to IS : 73, IS : 215, IS : 217 or IS : 454 as applicable and be of the grade specified.

Table 5.5: Physical requirements of coarse aggregates for Bituminous concrete (BC).

(As per TABLE 500-17: MOSRTH specifications)

PROPERTY	TEST	SPECIFICATION
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve.
Particle shape	Flakiness and Elongation Index	Max 30% (Combined) ²
Strength*	Los Angeles Abrasion Value ³	Max 30%
	Aggregate Impact Value ⁴	Max 24%
Polishing	Polished Stone Value ⁵	Min 55
Durability	Soundness: ⁶	
	Sodium Sulphate	Max 12%
	Magnesium Sulphate	Max 18%
Water Absorption	Water absorption ⁷	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures ⁹	Minimum retained coating 95%.
Water Sensitivity**	Retained Tensile Strength ⁸	Min 80%

5A.5.3. Earth work**5A.5.3.1 Earthwork in Excavation**

In general, the excavation shall be in accordance to Specifications specified elsewhere.

Profiles of road excavation shall be laid at 50 m intervals or as specified in Approved Drawings to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Employer's Representative in writing. If excavation is done below the specified level or outside the section the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted and tested as specified for the subgrade. The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections and side slopes as shown in the drawings or approved by Employer's Representative.

5A.5.3.2 Earthwork in Embankment

The embankment shall be formed of earth obtained from approved source as per Approved drawings and Shop drawings .

The ground over which embankment is to be formed shall be cleared of all brushwood, loose stones, vegetation, bushes, stumps, and all other objectionable matter and materials so removed shall be burnt off or disposed off as approved by Employer's Representative. The cost of this clearing, burning and disposal shall be included in the unit rates quoted for embankment construction.

Profiles of embankment shall be set up with stepped bench marks or concrete pillars or Steel Rods or masonry pillars section or stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and steel pegs at every 10 metres on straight portions. Toe line may be marked with pick marks.

Before placing any embankment material the top 150 mm of soil strata receiving it shall be scarified and watered and compacted with one pass of 8 to 10 Ton roller compactor .

Embankment material shall be placed in successive horizontal layers of 200 mm depth extending to the full width of the embankment including the slopes at the level of the particular layer and 300 mm more on both sides to allow compaction of the full specified section. Before placing the next layer the surface of the underlayer shall be with specified Moisture and scarified with pick axes or spades or by machines to provide a satisfactory bond with the next layer. The extra loose stuff at the edges shall be trimmed later after completion of the bank work leaving the correct section fully compacted to the satisfaction of the Quality Control Employer's Representative .

When boulders, broken stones and similar hard materials are mixed up with the embankment materials care shall be taken to see that they are distributed uniformly into the bank and that no hollows or holes are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, levelled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed water and prevent ponding or water logging or stagnation. If the bank materials contains less than the optimum moisture, water shall be added or sprayed by spraying pipes to the loose layers of the embankment to bring the moisture uniformly up to requirement. If the material contains more than the required moisture it shall be allowed to dry until the moisture is reduced to the required extent. The moisture / dried loose layers shall be compacted with a power roller of 10 to 12 tonnes or as specified by Employer's Representative in charge at Site. The roller shall pass at least six times over the same area, in the forward move first and in backward move and repeated till six times or till the desired compaction is attained or to the satisfaction of the Quality Control Employer's Representative . To allow for subsequent settlement for the Compaction the finished level of the embankment shall be kept higher than the specified level by one centimetre for every metre of the height of the bank.

Embankment shall be finished and dressed smooth and even to conform to the alignment, levels, cross sections, and dimensions shown on drawings with due allowance for shrinkage . Any damage caused by rain, or due to any other reason shall be made good in the finishing operation .

5A.5.4. Preparation of Subgrade

In general Earthwork in subgrade shall conform to Specifications specified elsewhere.

Immediately prior to the laying of the soling the subgrade shall be cleaned of all foreign substances, vegetation etc. Any ruts or potholes or soft yielding patches that appear shall be corrected by filling and ramming and compacting and the subgrade dressed off parallel to the finished profile. The camber of

subgrade shall conform in shape to that of the finished road surface. Camber boards shall be inspected and approved by Quality Control Employer's Representative shall be used to get the required section.

The prepared subgrade shall be lightly sprinkled with water, if necessary, and rolled with power roller of not less than 10 tons, till the soil is evenly compacted to 95% of Proctor density with 2%

Variation in optimum moisture content. Roller shall pass minimum 6 runs on the subgrade. Rolling shall commence at the edges and progress towards the center longitudinally. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. Any undulations in the surface that develop due to rolling shall be made good with approved earth and subgrade rerolled.

5A.5.5. Soling

Soling shall not be constructed on a wet subgrade.

Unless otherwise specified, the width of the soling shall be 230 mm more on either side than that of the water bound macadam wearing course and the finished thickness of the soling course shall be 230 mm. The soling stones shall be laid with the largest face downwards and in contact with each other. The stones shall break joint as far as possible. The height of the soling stone shall be equal to specified thickness of soling.

As the laying of rubble advances the soling shall be hand packed by wedging and packing with 80 mm metal in the joints of the soling and driving them by hammers in place so as to fill the voids as completely as possible. This operation of hand packing shall closely follow the rubble laying. The soling shall be laid and hand packed true to grade and section and these shall be often checked by boning / cleaning rods, template boards and fish line etc. The grades, sections etc. of the soling shall correspond to those of the surfacing coming on it. The soling thus laid shall be finished by knocking out projecting stones and filling depressions by chips to come up to the grade and camber.

The quality of the 80 mm metal shall be same as specified for the soling and the longest dimension shall not be more than 100 mm and the shortest dimension not less than 50 mm.

The soling after it is properly laid and hand packed including filling of voids with 80 mm metal shall be rolled dry with 10 - 12 T power roller to refusal i.e., till the stones in the soling course cease to move under the roller and no more compaction can be achieved. Rolling shall start at the edges and work towards the centre. The roller shall run over the same surface of rolling for at least 8 times till the soling course is well consolidated. The surface shall be checked by templates and in case of unevenness high spots shall be removed / knocked out and depressions filled by soles or rubble or spalls and shall be recompacted fully. Bunds shall be laid along the edges and compacted before starting rolling on soling to prevent spreading of stones.

Gravel shall be spread in thin layers over the above prepared soling surface, swept into the interstices with brooms, watered lightly to assist the filling of voids. Spreading of gravel, sweeping and watering shall continue till the interstices are completely filled. At all times only enough water shall be sprinkled to force the gravel into the voids and never so much as to soften the subgrade. The process of gravel filling shall be accompanied by rolling as for dry rolling of soling with a power roller weighing not less than 10 tonnes starting at edge and working towards the centre. The roller shall run over the same surface for at least eight times. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The surface shall be checked with templates of approved design (to be provided by Contractor) and high and low spots corrected by removing soling and repacking and shall be Inspected and approved by the Quality Control Employer's Representative and Employer's Representative in charge at the project Site

5A.5.6. Sub-base

5A.5.6.1 General

The sub-base shall not be constructed on a wet subgrade.

The width of the sub-base course shall be 150 mm more on either side than that of the water bound macadam wearing course. The finished thickness of the sub-base course shall be 160 mm. The sub-base metal course shall be laid in 2 layers, each of thickness 120 mm and finished to 80 mm.

5A.5.6.2 Spreading and Rolling

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

Immediately after the spreading of the Aggregates or stones metal, rolling shall be started with wheeled power rollers of 10 to 12 tonnes capacity or tandem or vibratory rollers of approved type. Rolling shall begin from the edges gradually progressing towards the centre. First the edge(s) shall be firmly compacted with roller running forward and backward. The roller shall then move inwards parallel to the centreline of the road, in successive passes uniformly lapping preceding tracks by at least one half width or as per approved drawings and in the Approved methods and Procedures.

Rolling shall be continued until the road metal has been thoroughly keyed and forward movement of stones ahead of the roller is no longer visible. Slight sprinkling of water may be done if necessary.

5A.5.6.3 Application of Screening

After the Aggregates or Stone metal has been thoroughly keyed and set by rolling, screening to completely fill the interstices shall be applied gradually over the surface. These shall not be in damp condition or wet condition at the time of application. Dry rolling shall be done while the screening is being spread so that vibrations of the roller cause them to settle in the voids. The screenings shall not be dumped in piles but be spread uniformly by spreading motion of hand shovels.

The dry rolling now shall be accompanied by brooming with hand brooms, wire brushes or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent, filling of voids or prevent the direct bearing of the roller on the metal. These operations shall continue until no more screenings can be forced into the voids in the metal.

5A.5.6.4 Sprinkling and Grouting

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

be Inspected and approved by the Quality Control Employer's Representative and recorded at site by the Contractor .

5A.5.7. Water bound Macadam Course

The surface over which water bound Macadam is to be laid shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. To prevent the spreading of the course aggregate during rolling, if necessary, two parallel mud walls 200 mm wide and of height equal to uncompacted Macadam course shall be made along the outer edges of the Macadam course having a clear distance between them equal to the width to be metalled.

W.B.M. sub-base course of specified thickness shall be provided. The course aggregate for this shall conform to requirements of sub-base in Table-5.1 and its grading shall conform to Grading 1 of Table - 5.3 and screening to Type B of Table-5.4.

W.B.M. base course : The coarse aggregate for this shall normally conform to requirements for Base in Table-1 and its grading shall confirm to Grading 3 of Table – 5.3 and screening to Type-B of Table-5.4.

5A.5.7.1 Preparation of Base

The base to receive the water-bound macadam course shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm.

5A.5.7.2 Spreading Coarse Aggregate

The coarse aggregates conforming to the specifications shall be spread uniformly upon the prepared base to 110 mm which shall be compacted to 80 mm.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted. All work shall be to the Satisfaction of the Quality control Employer's Representative and Employer's Representative in- charge

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread over more than 3 days in advance of the subsequent construction operations.

5A.5.7.3 Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 10 to 12 tonne capacity or tandem or vibratory rollers of approved types. The weight of the roller shall depend upon the type of aggregate and compaction surface and shall be indicated by the Employer's Representative.

Except on superelevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge(s) shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping the preceding tracks by at least one-half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of blindage. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or base course, if required some soft areas shall be replaced by recommended fill and rolling operation can be done again till to the satisfaction of Quality control Employer's Representative

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to the desired camber and grade. In no case shall the use of blindage be permitted to make up potholes and depressions.

5A.5.7.4 Application of Screening

After the coarse aggregate has been rolled in accordance with Clause 5A.5.8.3, screenings shall be applied gradually to completely fill the interstices over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers. Screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all the voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall screenings be applied fast and thick to form cakes and ridges on the surface that would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate. Spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

5A.5.7.5 Application of Blindage

After the coarse aggregate has been rolled, blindage conforming to specifications to completely fill the interstices shall be gradually applied over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the blindage is being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The blindage shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders or directly from trucks. Trucks operating for spreading the blindage shall be so driven as not to disturb the coarse aggregate.

The blindage shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. The rate of spreading blindage shall not be less than 3.00 cu.m or more than 4.50 cu.m per 100 sq.m. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall the blindage be applied so fast and thick, heaps as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. The operations shall continue until no more blindage can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of blindage shall be carried out in only such lengths of the road which could be completed within one day's operation.

5A.5.7.6 Application of Binding Material

After the application of screenings in accordance with Clauses 5A.5.8.4 and 5A.5.8.5, the binding material where it is required to be used (See Clause 5A.5.3.5) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled, during which water shall be applied to the wheels of the rollers, if necessary, to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

5A.5.7.7 Sprinkling and Grouting

After the blindage have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet blindage into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional blindage applied as necessary until the coarse aggregate had been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of blindage. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

5A.5.8. Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with blindage as directed, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Employer's Representative shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause damage to the surface.

Should the subgrade at any time become soft or churned up with the sub-base metal, or the water bound macadam course, the Contractor shall without additional compensation remove the mixture from the affected portion, reshape and compact the subgrade and replace the removed section in accordance with the foregoing requirements.

5A.5.8.1 Multiple Layered Course

When the total consolidated thickness of the water bound Macadam course is more than 100 mm, it shall be constructed in layers. Each layer shall be constructed as per all the operations described above. The same degree of quality control and refinement shall be used for constructing each layer. All works shall be recorded and approved by the Quality control Employer's Representative

5A.5.9. Semi-Grout**5A.5.9.1 Brushing**

Prior to spreading of 25 mm and 40 mm metal for asphalt surface, the water bound surface shall be swept clean to remove all Blindage so as to expose the metal surface.

5A.5.9.2 Semi Grout Surface 80 mm thick

After the surface is cleaned as above and after removing all loose and foreign matter, the coarse aggregate shall be spread upon the base in a uniform loose layer. The size of metal shall be 25 mm and 40 mm. Every precaution shall be taken to prevent the aggregate from mixing or being coated with dust or any other objectionable matter, before and after spreading.

The coarse aggregate shall then be dry rolled with a road roller weighing not less than 10 tonnes. The rolling shall start longitudinally at the sides and proceed towards the centre of the pavement, overlapping

on successive trips by at least one half of the width of the roller. The compacted coarse aggregate shall possess a fairly firm even surface, true to the grades and cross sections shown on the drawings and present a texture which will allow uniform penetration of the asphalt. If any irregularities appear during or after rolling, they shall be remedied by loosening the surface and removing or adding coarse aggregate as may be required, after which the area disturbed, including the sounding surface shall be rolled, until satisfactorily compacted to a uniform surface. All coarse aggregate which becomes coated or mixed with dirt, dust or foreign substance, prior to the application of asphalt shall be removed and replaced by clean aggregate of the same kind and compacted as specified.

5A.5.9.3 First Application of Bitumen

Upon the rolled coarse aggregate, bitumen of grade S35 or S65 heated to a temperature of 204 °C (400°F) and quality as specified shall be uniformly applied at the rate of 5.5 kg/m² using gravel or coarse sand to reduce the interstices between the metal before application if it is found that the quantity of bitumen specified is insufficient to fill the interstices satisfactorily. Bitumen shall be applied only when the course is thoroughly dry for its entire depth and passed by the Employer's Representative. Bitumen shall be applied hot by means of a pressure distributor as described below :

The pressure distributors used for applying bitumen shall be equipped with pneumatic tyres and shall be so designed and operated as to distribute the bitumen in a uniform spray without atomization in the amount and between the limits of temperature, specified. It shall be equipped with a fifty wheel speed tachometer registering feet per minute and so located as to be visible to the truck driver to enable him to maintain the constant speed required for application at the specified rate. The pump shall be operated by a separate power unit or by the truck power unit. It shall be equipped with a tachometer registering gallons per minute passing through nozzles and readily visible to the operator. Suitable means for accurately indicating at all times the temperature of the bitumen shall be provided. The thermometer shall be so placed as not to be in contact with the heating tube. The distributor shall be so designed that the normal width of application shall not be less than 2 m. with provision for the application of lesser width when necessary. If provided with heating attachments, the distributor shall be so equipped and operated that the bitumen shall be circulated or agitated throughout the entire heating process. All the above works shall be inspected and approved by the quality control Employer's Representative and recorded for claim of Billing Purpose .

5A.5.9.4 Filling surface voids with intermediate aggregate

After the first application of asphalt and while still warm, a thin layer of dry intermediate aggregate consisting of 12.5 mm metal chips conforming to the specifications for physical requirements and grading shall be casted over the treated surface at a rate of 2.1 cubic metres per 100 square metres or in such quantity as to fill the surface voids and just cover the first coat. It shall be broomed if necessary to break up all heaps and produce a uniform covering, after which the pavement shall be rolled until

thoroughly compacted and interlocked, and Inspected by the Quality control Employer's Representative or by the Employer's Representative in charge

Suitable precautions shall be taken to prevent the distribution of intermediate aggregate over portion of the coarse aggregate which has not received the application of asphalt and in no case shall be dumped directly upon either the treated or untreated coarse aggregate.

5A.5.9.5 Protection of Semi Grout

During the period, between the initial compaction of the coarse aggregate and completion of the seal coat, the surface shall be protected from all traffic other than absolutely essential.

5A.5.10. Premixed Asphaltic Carpet

This work shall consist of constructing in a single course of 50 mm thick Premixed Asphaltic Carpet to the following Employer's Requirements on a previously prepared base, to serve as a wearing coat, and Inspected and Approved by the Site Quality Control Employer's Representative

5A.5.10.1 Materials*Binder*

This shall be paving bitumen of penetration grade within the range S 35 to S 90 or A 35 to A 90 (30-40 to 80/100) as per Indian Standard for 'Paving Bitumen' IS: 73. The actual grade of bitumen to be used shall be decided by the Employer's Representative appropriate to the region, traffic, rainfall and other environmental conditions.

Coarse Aggregate

It shall be crushed material retained on 2.36 mm (No. 8 ASTM) sieve and shall be crushed stone or gravel (shingle) and shall be as per Clause 5.3.3 and satisfy the physical requirements set forth in Table-5.2.

Fine Aggregates

The fine aggregates shall be the fraction passing 2.8 mm sieve and retained on 90 micron sieve consisting of crusher run screenings, natural sand or mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or deleterious substances and shall satisfy the Quality control and assurance check list and IS codes.

Filler

The filler shall be an inert material, the whole of which passing 710 micron, sieve, at least 90 percent passing 180 micron sieve and not less than 70 percent passing 90 micron sieve. The filler shall be stone dust, cement, hydrated lime, fly ash or any other non-plastic mineral matter approved by the Employer's Representative.

5A.5.10.2 Mineral Aggregate Gradation

The mineral aggregates including mineral filler shall be so graded or combined as to conform to the either of the limits set forth in Table-5.6 below :

Table –5.6 Mineral Aggregate Gradation for Bituminous Concrete

Sieve Size	Percent by Weight Passing the Sieve	
	GRADING - 1	GRADING - 2
20mm	---	-100
12.5 mm	-100	80-100
10 mm	80-100	70-90
4.75 mm (No.4 ASTM)	55-75	50-70
2.36 mm (No.8 ASTM)	35-50	35-50
600 Micron (No.30 ASTM)	18-29	18-29

300 micron (No.50 ASTM)	13-23	13-23
150 micron (No.100 ASTM)	8-16	8-16
75 micron (No.200 ASTM)	4-10	4-10

5A.5.10.3 Mix Design

Apart from conformity with the grading and quality requirements of individual ingredients, the asphaltic concrete mix shall meet the requirements set forth in Table-5.7 hereunder

5A.5.10.4 Weather and Seasonal Limitations

Asphalt concrete shall not be laid during rainy weather or when the base course is damp or wet.

Table – 5.7 Requirement of Asphaltic Concrete Mix

S. No.	Description	Requirements
1.	Number of compaction blows, each end of Marshalling specimen	50
2.	Marshall stability (ASTM Designation-D-1559) determined on Marshall specimen	340 Kg. (min.)
3.	Marshall flow (mm)	2-4
4.	Percent Voids in mix	3-5
5.	Percent voids in mineral aggregate filled with bitumen	75-85
6.	Binder content percent by weight of mix	5-7.5

The contractor shall intimate to the Employer's Representative in writing, well in advance of the start of work, the job- mix or the design mix ratio or formula proposed to be used for the work and shall submit the details to the Employer's Representative for his approval.

- i) Source and location of all materials
- ii) Proportions of all materials expressed as follows where each is applicable :

Binder	As percentage by weight of total mix
Course aggregate	As percentage by weight of total aggregate including mineral filler
Fine aggregate	
Mineral filler	

- iii) A single definite percentage passing each sieve for the mixed aggregate.
- iv) The results of the best enumerated in Table-5.7 as obtained by the Contractor.
- v) Test results of physical characteristics of aggregates to be used.

Should a change in the source of material be proposed, a new job mix formula shall be established and got approved from the Employer's Representative before actual using the materials.

5A.5.10.5 Preparation of Base

The base on which premix carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section by repairing all potholes or patches and ruts. The potholes shall be drained of water and cut to regular shape with vertical sides. All loose and disintegrated material shall be removed. The pothole shall then be filled either with (i) Coarse aggregate and screenings conforming to Clause 5.3.0 and compacted with heavy hand rammers or approved mechanical tampers or (ii) premixed chippings binders (bitumen grade 80/100) content of 3 percent by weight of total mix, after painting the sides and bottom of the holes with a thin application of bitumen, or a combination of both (i), (ii) as approved by Employer / Employer's Representative. The surface shall be thoroughly swept and scraped clean and free of dust and other foreign matter and made ready for Inspection .

5A.5.10.6 Tack Coat

The binder used for tack coat shall be bitumen of suitable penetration grade within 80 / 100 confirming to IS:73. The actual grade of bitumen to be used shall be decided by the Employer's Representative, appropriate to the region / surface condition, traffic, rainfall and other environmental conditions. Binder shall be heated to the temperature appropriate to its grade and as approved by the Employer's Representative. The binder shall be sprayed on the prepared base at the rate of 1.0 kg / sq.m. The binder shall be applied uniformly with the aid of either self propelled or towed bitumen pressure sprayer with self heating arrangement and spraying nozzle arrangement capable of spraying bitumen at the above specified rate and temperature so as to provide uniform unbroken spread of bitumen. The tack coat shall be applied just ahead of oncoming premixed asphalt carpet.

5A.5.10.7 Preparation of Mix and Laying

Hot mix plant approved by the Employer's Representative in charge and of adequate capacity and capable of producing a proper and uniform quality mix shall be used for preparing the mix. The plant may be either a weigh batch type or volumetric proportioning continuous or drum mix type. The stone aggregate shall be surface dry and contain not more than 2 percent moisture before use. It shall be first screened of dust and measured in boxes, heated to 155 deg.C - 163 deg. C and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion specified. The binder shall be heated to 140 deg. C to 177 deg. C in boilers and maintained at that temperature. At no time shall the difference in temperature between the aggregate and binder exceed 14 deg. C. The heated binder shall be drawn from the boiler into a suitable container or in a bucket gauged to show the weight of bitumen in it.

Mixing shall be done in two stages. The coarse aggregate of the correct standard size and in the proportion as specified shall be fed into the mixer to which 2 / 3rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the coarse aggregate is well coated, the fine aggregate in the specified proportion followed by the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

The hot mix shall be discharged from the mixer carried to the point of use in suitable tipper vehicles and shall be spread by means of a self propelled mechanical paver with a suitable screeds capable of spreading, tamping and finishing the mix to specified lines and levels to a thickness sufficient to achieve after consolidation, the specified thickness. Temperature of the mix at the time of laying shall be in the

range of 120 deg. C - 160 deg. C. However, in restricted locations and in narrow width where available equipment cannot be operated in the opinion of the Employer's Representative, he may permit manual laying of the mix. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150 mm from those in the binder course (tack coat). All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

5A.5.10.8 Rolling

Immediately after the spreading of mix it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km per hour. The initial or break down rolling shall be with 8-12 ton three wheel roller and the surface finished by final rolling with the 8-10 ton tandem roller. Preferably before finishing with tandem, breakdown rolling shall be followed by an intermediate rolling with a fixed wheel pneumatic roller of 15 to 30 ton having a tyre pressure of 7 kg. per sq.m. The joints and edges shall be rolled with a 8 to 12 ton three wheel roller. Any high spots or depressions which become apparent shall be corrected by addition or removal of mix material. The roller shall uniformly overlap not less than a third of the track made in the preceding pass. The wheels of the roller shall be moistened with gunny bags to prevent the mix sticking to the wheels while rolling, but in no case shall fuel lubricating oil be used for this purpose. Rolling shall be continued till the mix is thoroughly compacted and all roller marks are eliminated.

5A.5.10.9 Opening to Traffic

Traffic shall be allowed on the road after a lapse of minimum 24 hours, preferably 48 hours after laying as approved by the Employer's Representative.

5A.5.11. Seal Coat

This work shall consist of application of a seal coat sealing the voids in a bituminous surface laid to the specified levels, grade and camber. Seal coat shall be either of the two types below

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

5A.5.11.1 Materials

Binder

This shall be 30/40, 60/70 or 80/100 grade straight run bitumen conforming to IS:73. The actual grade of bitumen to be used shall be approved by the Employer's Representative, appropriate to the specific region, traffic, rainfall and other environmental conditions. The quantity of binder to be utilized, shall be 9.8 kg and 6.8 kg per 10 sq.m of area for Type A and Type B seal coat respectively.

Stone Chippings for Type A Seal Coat

These shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They should be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 10 mm size defined as 100 percent passing through 12.5 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cum per 10 sq.m.

Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cu.m per 10 square metre area.

5A.5.11.2 Preparation of Base

The seal coat shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter. All the completed works shall be Inspected and approved by the Quality control Employer's Representative and records shall be maintained for Claim of Billing .

5A.5.11.3 Construction of Type A Seal Coat

Application of Binder

Binder shall be heated in boilers to 163 deg. C to 171 deg. C, maintained at the temperature and sprayed on the dry surface in a uniform manner with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer through leakage or any other reason shall be suitably removed or corrected before the stone chippings are spread.

Application of Stone Chipping

Immediately after the application of the binder, stone chippings in a dry and clean state shall be spread uniformly on the complete surface. If necessary the surface shall be broomed to ensure uniform spread of chippings. The surface shall be checked by means of an approved camber board laid across the road and a 3 metre straight edge laid parallel to the centre line of the road and undulations if any, shall be corrected by addition or removal of blindage.

Rolling

Immediately after the application of the material, the entire surface shall be rolled with a 8 to 10 tons smooth wheeled roller. While rolling is in progress additional material shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all material is firmly bedded in the binder and presents a uniform closed surface. Generally, five to six passes shall be made for thorough compaction of the surface or as approved by the Employer's Representative. Along kerbstones, manholes and at all places not accessible to roller, thorough compaction shall be secured by means of steel rammers or hand rollers. Traffic shall be allowed after 24 hours after the Inspection and approval of the Quality control Employer's Representative. After a period of seven days, surplus grit shall be swept and collected and shall be used for binding the spots where bleeding occurs.

5A.5.11.4 Construction of Type B Seal Coat

Preparation of Mix and Laying

The aggregate shall be surface dry and contain not more than 2 percent moisture before use and shall be heated to 155 deg. C to 163 deg. C and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion specified. The binder shall be heated to 149 deg. C to 177 deg. C in boilers and maintained at that temperature. At no time shall the difference in temperature between the aggregate and binder exceed 14 deg. C. The heated binder shall be drawn from the boiler into a suitable container or in a bucket gauged to show the weight of bitumen in it. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to

be sealed. All these works shall be Inspected and approved by the Quality Control Employer's Representative.

Rolling

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 8 to 10 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in bituminous course and a smooth uniform surface is obtained. All the rolling will be supervised for the Number of rolling and for compaction by the Employer's Representative and all the roller shall have calibration and periodical inspection Certificate.

Opening to traffic

Traffic may be allowed soon after final rolling when, the premixed material has cooled down to the surrounding temperature. Opening to traffic shall be done after the Approval of the Employer's Representative in charge

5A.5.12. Quality Control

5A.5.12.1 General

All materials incorporated and all works performed shall be strictly adhere to conformity with the Specification requirements. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as approved by the Employer's Representative subject to the permitted tolerances described hereinafter. The Contractor shall be fully responsible for the quality of the work in the entire construction within the Contract. He shall, therefore, have his own independent and adequate set-up for ensuring the same.

The Contractor shall carry out quality control tests on the materials and work to the frequency specified. In the absence of clear indications about method and/or frequency of tests for any item, the approval of the Employer's Representative shall be obtained, and he shall provide necessary co-operation and assistance in obtaining the samples for test and carrying out the field test as required by the Employer's Representative from time to time. This may include provision of Labour, attendance, assistance in packing and despatching and any other assistance considered necessary in connection with the test.

For the work of embankment, subgrade and construction of subsequent layer of same or other material over the finished layer shall be done after obtaining approval from the Employer's Representative. Similar approval from the Employer's Representative shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

The Contractor shall carry out modification in the procedure of work, if found necessary, as approved by the Employer's Representative during inspection. Works falling short of quality shall be rectified by the Contractor as approved by the Employer's Representative.

The Contract rate quoted for various items of works in the Bill of Quantities or the lumpsum amount tendered shall be deemed to be inclusive of all costs of the quality control tests and operations necessary for ensuring quality of the material and work so as to be in conformity with the specification requirement.

5A.5.12.2 Permitted Tolerances

Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25 mm

therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 40 mm.

Longitudinal Profile

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross- profile of the road shown on the drawings or as approved by the Employer's Representative beyond the tolerances mentioned below :

Subgrade	± 15 mm
Sub-base	± 20 mm
Base Course	± 15 mm
Wearing Course	± 10 mm

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

Surface Regularity

The surface regularity of completed subgrade, sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table 5.8.

The longitudinal profile shall be checked with a 3 metre long straight edge, at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres by the concern Quality Inspection Employer's Representative.

Rectification

Where the surface irregularity of subgrade and the various courses fall outside the specified tolerances, the Contractor shall be liable to rectify by his own cost for these in the manner described below and to the satisfaction of the Employer's Representative.

(i) Subgrade

Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by adding fresh material. The degree of compaction and the type of material to be used shall conform to the Clauses 5.3 and 5.4.

(ii) Water Bound Macadam

Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompact. The area treated at a place shall not be less than 5 metres long and 2 metres wide.

(iii) Bituminous Constructions

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

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to Specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 metre long and not less than 1 lane wide.

Table 5.8 Permitted Tolerance of Surface Regularity for Subgrade and Pavement Courses

S. No.	Type of Construction	Longitudinal profile with 3 Cross profile metre straight edge					
		Maximum permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding : mm				Maximum permissible variation from specified profile under camber template : mm
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen subgrade	24	30	-	-	-	15
2.	Granular/Lime/Cement/stabilised subbase	15	-	30	-	-	12
3.	Water Bound Macadam with over size metal (45-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (22-4-53 mm and 45-63 mm size)	12	-	-	30	-	8
5.	Bituminous concrete	8	-	-	-	10@@	4

Notes :

1. @@ These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Employer's Representative. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

2. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

5A.5.13. Tests

5A.5.13.1 General

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Employer's Representative shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Specifications.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned,

the tests shall be carried out as per the prevalent accepted Engineering practice to the approval of the Employer's Representative.

Tests on Earthwork for Embankment and Subgrade Construction

Borrow material

- (i) Sand content [IS:2720(Part IV)]

1-2 tests per 8000 cu. metres of soil

- (ii) Plasticity Test [IS:2720(Part V)]

Each type to be tested , 1-2 tests per 8000 cu. metres of soil.

- (iii) Density Test [[IS:2720(Part VII)].

Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil.

- (iv) Deleterious Content Test [IS:2720(Part XXVII)]

As and when required by the Employer's Representative.

- (v) Moisture Content Test [IS:2720(Part II)]

One test for every 250 cubic metres of soil.

- (vi) CBR Test on materials to be incorporated in the subgrade on soaked / unsoaked samples [[IS:2720(part XVI)]

One test for every 3000 m³ at least or closer as and when required by the Employer's Representative.

Compaction control: Control shall be exercised by taking at least one measurement of density for each 1000 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a days work on statistical basis. The determination of density shall be in accordance with IS:2720 (part XXVIII). Tests 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 borrow material and the method of compaction is being exercised. 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 subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm / cc.

However, for earthwork in shoulders (earthen) and in top 500 mm portion of the embankment below the subgrade, at least one density measurement shall be taken for every 50 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

5A.5.13.2 Tests on Sub-bases and Bases (Excluding bitumen bound bases)

The tests and their frequencies for the different types of bases and sub-base shall be as given in Table 5.9. The evaluation of density results for compaction control shall be on lines similar to those set out in clause 5.10.1.

Table –5.9 Control Tests and Their Frequencies for Sub-Bases and Bases (Excluding Bitumen Bound Bases)

S. No.	Types of Construction	Test	Frequency
1.	Granular sub-base	i) Gradation ii) Atterberg's limit iii) Moisture content prior to compaction iv) Density of compacted layer v) Deleterious constituents vi) C.B.R	One test per 200 m ³ One test per 200 m ³ One test per 250 m ² One test per 500 m ² As required As required
2.	Lime/Cement Stabilised	i) Purity of lime (for lime-soil stabilization) ii) Lime/Cement content iii) Degree of pulverisation iv) CBR test on a set of 3 specimens v) Moisture content prior to compaction vi) Density of compacted layer vii) Deleterious constituents	One test for each consignment subject to a minimum of one test per 5 tonnes of lime. Regularly, through procedural checks. Periodically as considered necessary. As required One test per 250 m ³ . One test per 500 m ² As required
3	Water Bound Macadam	i) Aggregate Impact Value ii) Grading iii) Flakiness Index iv) Atterberg's limits of binding material.	One test per 200m ³ of aggregate One test per 100 m ³ of aggregate One test per 200 m ³ of aggregate One test per 25 m ³ of binding material

All test sample shall be confirm to IS codes .

5A.5.13.3 Tests on Bituminous Constructions

The tests and their frequencies for the different types of bituminous works shall be as given in Table 5.10 hereunder.

Table – 5.10 Control Tests and Their Frequency for Bituminous Works

S. No	Types of Construction	Test	Frequency
1.	Prime Coat / Tack Coat	i) Quality of binder ii) Binder temperature for a application Rate of spread of binder	As Required At regular close intervals Two tests per day
2.	Seal Coat / Surface Dressing	i) Quality of binder ii) Aggregate Impact Value iii) Flakiness Index iv) Stripping value of aggregates v) Water absorption of aggregates vi) Grading of aggregates vii) Temperature of binder of application Rate of spread of materials .	As required One test per 50 m ³ of aggregate One test per 50 m ³ of aggregate Initially, one set of 8 representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregate One test per 25 m ³ of aggregate At regular close intervals One test per 500 m ³ of aggregate .
3	Bituminous Concrete	i) Quality of binder ii) Aggregate impact value, flakiness index and stripping value of aggregates iii) Mix-grading	As required One test per 50-100m ³ of aggregate One set of test on individual constituents and mixed aggregates from the dryer for each

S. No	Types of Construction	Test	Frequency
		iv) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling v) Stability of mix (vide ASTM:D-1559) vi) Binder content and gradation in the mix (Binder content test vide ASTM:D-2172) vii) Rate of spread of mixed material Density of compacted layer	100 tonnes of mix subject to a maximum of two sets per plant per day. At regular close interval. For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value density, and void content, subject to a minimum of two sets being tested per plant per day. One test for each 100 tonnes of mix subject to a minimum of two tests per day per plant. Regular control through checks on the weight of mixed material and layer thickness. One test per 500 m ³ area

5A.5.14. Slab Culvert

Slab culverts shall be constructed at specified locations of the existing cross drainage works as per drawings, or as directed by the Employer's Representative. The Concrete works specifications for construction of RC slab and the rubble masonry specifications for the supporting rubble walls are given in Section-4 and Section-8 respectively and they shall be followed.

5A.5.14.1 Bitumen at Location of Contact

The Bitumen to be used on the top of the bed concrete at the location of contact of RCC slab above in two coats, shall be straight run bitumen of specified grade.

5A.5.14.2 Graded Gravel Free Draining Backfill

On each side of the uncoursed rubble walls supporting the slab culvert a free draining backfill of thickness 200 mm shall be provided. The material for this backfill shall be granular consisting of sound, tough, durable particles of crushed or uncrushed gravel, crushed stone or brickbats which will not become powdery under loads and in contact with water. The material shall be free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be graded and shall meet the grading requirements given in Table 5.11 hereunder.

Table 5.11

Sieve Designation	Percent Passing by Weight
10 mm	100
4.75 mm	30-65
425 microns	5-30
150 microns	0-10

5A.5.14.3 Weep Holes

Weep holes as shown on the drawings or as directed by the Employer's Representative shall be provided in the masonry to drain water from the backfilling. Weep holes shall be of asbestos cement pipes conforming to IS 6908 in rubble walls with necessary M10 concrete cushioning, 75 mm thick. They shall extend through the full width of the masonry at a spacing of 1.5 m c/c and with slope of about 1 vertical to 20 horizontal (or as shown on the drawings) towards the draining face.

5A.5.15. Pipe Drains

Wherever required, pipe drains shall be provided for cross drainage purposes. The sequence of construction shall be as follows:

- laying of sand/shingle bedding on the original ground,
- laying of PCC of M10 grade,
- laying of concrete pipes of NP3 class as per IS 458,
- Constructing embankment above in compacted Muram, laying of the sub-base and Water bound Macadam as specified herein above.

The details of above works as directed by Employer's Representative shall be followed.

5A.5.15.1 Materials for Pipe Drains

All materials used in the construction of pipe drains shall conform to the requirements of the Specifications. RCC pipes of NP3 class shall conform to IS 458.

Each consignment of cement concrete pipes shall be inspected, tested if necessary, and approved by Employer's Representative at the place of manufacture or at site before their incorporation in the Works.

5A.5.15.2 Excavation for pipes

The foundation bed for pipe drain shall be executed true to the lines and grades shown on the approved drawings or as directed by the Employer's Representative. The pipes shall be placed in shallow excavation of the natural ground in open trenches cut in the existing embankment, taken down to levels as shown in the drawings. Where trenching is involved, its width on either side of pipe shall not be less

than 150 mm nor more than one third the diameter of pipe. The sides of the trench shall be as nearly vertical as possible.

When during excavation, the material encountered is soft, spongy or other unstable soil, unless other special construction methods are called for as indicated on drawings, such unsuitable material shall be removed upto a depth of 600 mm or as directed by the Employer's Representative. Before placing any backfill material, exposed surface of the soft soil shall be lightly compacted with one pass of 0.5 T roller. On the lightly compacted surface, coarse sand and shingle shall be spread in two successive layers of 300 mm and each layer shall be compacted by rolling with a min.0.5 T roller and with a minimum of 10 passes each, both in longitudinal and transverse directions.

When bed rock or boulder strata are encountered, excavation shall be taken down at least 300 mm below bottom level of pipe as directed by Employer's Representative and space filled with approved sand and shingle and thoroughly compacted to provide adequate support for the pipes.

Trenches shall be kept free from water until the pipes are installed and the joints have been hardened . For this purpose, Contractor shall suggest necessary method for diverting the water.

5A.5.15.3 Bedding for pipe

The bedding surface shall provide a firm foundation of uniform density throughout the length of the pipe drain and shall conform to the specified level and grade.

The pipe shall be bedded in a cradle of concrete having a mix not leaner than M-10. The pipes shall be laid on the concrete bedding before the concrete has set by the approved suitable mechanical means .

5A.5.15.4 Laying of pipes

No pipe shall be placed in position until the foundations have been approved by Employer's Representative. When pipes are to be laid adjacent to each other, they shall be separated by a distance at least equal to or greater than half the diameter of pipe subject to a minimum of 450 mm.

The laying of pipes on the prepared concrete foundation shall start from the outlet and proceed towards the inlet and be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid they form a drain with a smooth uniform invert.

Any pipe found defective or damaged during laying shall be removed at the cost of the Contractor.

5A.5.15.5 Jointing

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

5A.5.15.6 Back filling

Trenches shall be backfilled with selected Murram as per specifications given in this part. Backfilling upto 0.3 metre above the top of pipe shall be carefully done and Murram shall be thoroughly consolidated under the haunches of the pipe.

5A.5.16 Measurement**5A.5.16.1 Slab Culvert**

- a) Measurement of in-situ concrete work shall be as specified in Section 4 of this specifications.
- b) Measurement of masonry shall be as specified in Section 8 of this specifications.
- c) Bitumen at locations of contact with concrete surface shall be measured in square metres over area covered in approved plan and the rates shall include cleaning the surfaces, applying in two coats, etc., as specified.
- d) Graded gravel free draining backfill shall be measured in cubic metres and the rate shall include supplying, backfilling, etc., as specified.
- e) Measurement for weep holes shall be running metres and the rates shall include providing and fixing in rubble masonry walls with necessary concrete cushioning to lines and levels as specified.

5A.5.16.2 Pipe Drains

Ancillary works such as excavation, backfilling, laying P.C.C below pipe, etc., shall be paid for separately, as provided under respective clauses.

5A.6 - STRUCTURAL STEEL WORK

5A.6.1. Applicable Codes and Specifications

The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

- | | | |
|----|-----------|---|
| 1. | IS:110 | Ready Mixed paint, brushing, grey filler for enamels for use over primers. |
| 2. | IS:158 | Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting. |
| 3. | IS:159 | Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required. |
| 4. | IS:341 | Black Japan, Types A, B and C |
| 5. | IS : 800 | Code of Practice for General Construction in Steel |
| 6. | IS : 801 | Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction |
| 7. | IS : 803 | Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks |
| 8. | IS : 806 | Code of Practice for Use of Steel Tubes in General Building Construction |
| 9. | IS : 808 | Dimensions for Hot Rolled Steel sections |
| 0. | IS : 814 | Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel |
| 1. | IS : 816 | Code of Practice for use of Metal Arc Welding for General construction in Mild Steel |
| 2. | IS : 822 | Code of Procedure for Inspection of Welds |
| 3. | IS : 1161 | Steel Tubes for structural purposes |
| 4. | IS : 1182 | Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates |
| 5. | IS : 1200 | Method of Measurement in Building Civil Works |
| 6. | IS : 1239 | Mild steel tubes, tubulars and other Wrought steel fittings |
| | | Part 1 – Mild steel tubes |
| | | Part 2 – Mild steel tubulars and other wrought steel pipe fittings |

7.	IS : 1363 (Parts 1 to 3)	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)
8.	IS : 1367 (All parts)	Technical Supply Conditions for Threaded Fasteners
9.	IS : 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
10.	IS : 1573	Electroplated Coating of Zinc on Iron and Steel
11.	IS : 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products
12.	IS : 1977	Structural Steel (Ordinary Quality)
13.	IS : 2062	Steel for General Structural Purposes
14.	IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
15.	IS:2339	Aluminium paint for general purposes, in Dual container
16.	IS : 2595	Code of Practice for Radiographic Testing
17.	IS : 2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
18.	IS : 2633	Method of Testing Uniformity of Coating on Zinc Coated Articles
19.	IS:2932	Specification for enamel, synthetic, exterior, type 1, (a) undercoating, (b) finishing
20.	IS:2933	Specification for enamel, exterior, type 2, (a) undercoating, (b) finishing
21.	IS : 3502	Steel Chequered Plate
22.	IS : 3658	Code of Practice for Liquid Penetrant Flaw Detection
23.	IS : 3757	High Strength Structural Bolts
24.	IS : 4000	High Strength Bolts in Steel Structure – Code of Practice
25.	IS : 4736	Hot Dip Zinc coating on Mild steel tubes
26.	IS : 4759	Hot Dip Zinc coating on Structural Steel and other Allied products
27.	IS : 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
28.	IS : 5369	General Requirements for Plain Washers and Lock Washers
29.	IS : 5372	Taper Washers for Channels
30.	IS : 5374	Taper Washer for 1 Beams
31.	IS:5905	Sprayed aluminium and zinc coatings on Iron and Steel.
32.	IS:6005	Code of practice for phosphating of Iron and Steel.

13.	IS : 6158	Recommended Practice for Safeguarding against Embrittlement of Hot Dip Galvanised Iron and Steel
14.	IS : 6159	Recommended Practice for Design and preparation of Material Prior to Galvanising
15.	IS : 6610	Heavy Washers for Steel Structures
16.	IS : 6745	Methods for Determination of Weight of Zinc Coating on Zinc coated Iron and Steel Articles
17.	IS : 7205	Safety Code for Erection of Structural Steel Work
18.	IS : 7215	Tolerances for Fabrication of Steel Structures
19.	IS : 8500	Structural Steel-micro alloyed (medium and high strength qualities)
20.	IS : 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel
21.	IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
22.	IS:13183	Aluminium paint, Heat resistant.
23.	AISC	Specifications for Design, Fabrication and Erection of Buildings

5A.6.2. Steel Materials

Steel materials shall comply with the codes referred to in Sub-Clause 5A.6.1.

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(St 42-0) | : | For structures not subjected to dynamic loading other than wind loads such as :

Platform roofs, foot over bridges, building, factory sheds etc. |
| Fe10-0(St 42-0) | : | Grade steel shall not be used
a) If welding is to be employed for fabrication
b) If site is in severe earthquake zone
c) If plastic theory of design is used |

5A.6.3. Drawings prepared by the Contractor

The Contractor shall prepare all drawings for design, 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 Contractor shall not commence detailing unless Engineer's design drawings are officially released for preparation of shop drawings. The Contractor shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made by the Employer's Representative.

All fabrication drawings shall be submitted to the Employer's Representative for approval before commencement of work .

No fabrication drawings will be accepted for Employer's Representative's approval unless checked and approved by the Contractor's qualified structural Employer's Representative and accompanied by an erection plan showing the location of all pieces detailed by approved shop drawings. The 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 Contractor only after Employer's Representative's approval of fabrication drawings. Approval by the Employer's Representative of any of the drawings shall not relieve the Contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The Employer's Representative'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 Contractor and all subsequent revisions etc. shall be at the cost of the Contractor for which no separate payment will be made.

5A.6.4. Fabrication

5A.6.4.1 General

All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All works shall satisfy Safety engineer / officer and Quality Control Engineer Satisfaction .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 and shall be grinded for smoothness if required . Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the Employer's Representative, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the workshops shall be kept clean and protected from weather.

5A.6.4.2 Connections

Shop / field connections shall be done 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 as per existing work condition.

All connections and splices shall be designed for full strength of members or loads as per approved torque. 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 and drain off water and shall have drain holes provided without any leakage.

5A.6.4.3 Straightening

All materials shall be straight and, if necessary, before being worked shall be straightened and /or flattened by pressure by suitable machines and shall be free from twists. Long plates shall be straightened by passing through a mangle or leveling rolls and structural shapes by the use of mechanical or hydraulic bar / section straightening machines. Heating or forging shall not be resorted to without the prior approval of the Quality Control Engineer and Engineer in charge and Employer's Representative in writing.

5A.6.4.4 Cutting

All Safety Precautions shall be adopted and approved by Safety officer prior to Cutting

Cutting may be shearing, cropping, sawing or machine flame cutting / Gas Cutting if permitted by the Employer's Representative. All re-entrant corners shall be shaped notch-free to a radius of at least 12mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs. The kerf on machine flame cut edges shall be removed. Where machine flame cutting is permitted for high tensile steel, special care shall be taken to leave sufficient margin and all flame hardened material shall be removed by machining/ edge planning. Hand flame cutting shall be undertaken only if so permitted by the Employer's Representative and shall only be carried out by and expert in such work. Hand flame cut edges shall be ground smooth and straight.

5A.6.4.5 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.

5A.6.4.6 Punching and Drilling

Holes in secondary members such as purlins, girts, lacing bars, etc may be punched nail size through materials not over 12 mm thick. Holes must be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances, such parts shall be first assembled, then tightly clamped together and drilled through. Sub-punching may be permitted before assembly, provided the holes are Punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not, even in such case, exceed 16 mm. When batch-drilling is carried out in one operation through two or more separable parts, these parts shall be separated after drilling and the burrs removed. Holes for turned and fitted bolts shall be drilled to a slightly smaller

diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to H 8 tolerances specified in IS: 919. Where reamed members are taken apart for shipping or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No inter-change of reamed parts will be permitted, Poor matching, over-drilling, and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

5A.6.4.7 High Strength Friction Grip Bolting

High strength friction grip bolts and nuts shall conform to IS: 3757. Installation of high strength friction grip bolts in joints shall comply with IS: 4000. The diameter of the bolt holes must not be more than 1.5mm larger than the nominal diameter of the bolt. All contact surfaces in a connection including those associated with the not heads, nut in a washers, shall be free of scale, burrs, dirt and other foreign matter tending to inhibit uniform sealing of the joint components/ nuts and washers need not be removed. All fasteners in a joint shall be tightened to a tension equal to or greater than the specified proof load shown in the following table, either by the calibrated method or the turn-of-nut method.

Bolt Size	Proof Load (Kg)	
	Bolts to I.S. 37S7-BG	Bolts to I.S. 3757-1 OK
M16	9120	10790
M20	14700	17150
M22	18180	21210
M25	21180	23710
M27	27450	32130
M33	41640	48580

Tightening may be achieved by use of pneumatic powered impact wrenches, long-handled manual torque wrenches with or without torque multipliers or electric wrenches. A hardened washer shall be placed under the element being turned. Bolts shall be tightened at the most rigid portion of the joint, proceeding towards the free edges.

When using the calibrated wrench method, adjustable power impact wrenches and manual torque wrenches shall be calibrated to induce bolt tensions of 5 percent in excess of the proof load values for each size of bolt to be used in installation. Every wrench shall be calibrated by having it tighten a minimum of three bolts of the same diameter, in a hydraulic tension measuring device. Calibration shall be repeated whenever a wrench is required to tighten a different size bolt, or at least once each working day if there is no change in the bolt size. Impact wrenches shall be set so as to shall or cut at the torque effort corresponding to the prescribed fastener tension. When manual torque wrenches are used, the torque indication corresponding to the calibrating tension shall be determined and taken as the job standard. Torque measurements shall be read while the turned element is in tightening motion. As subsequent tightening of bolts in any particular assembly is liable to loosen bolts already tightened, all bolts must be "Touched up".

When using the turn of nut method a sufficient number of bolts must initially be 'snugged up' to bring the connection components into full contact, by either a standard power impact wrench or an ordinary spud wrench. Snug tight condition shall indicate the point at which the turned element ceases to rotate freely and the impact wrench begins to impact or if a common spud wrench is employed, snug tightness shall mean the position resulting from the full effort of a man. Subsequently, the remaining bolts in the joints shall also be brought to snug tightness. All nuts and projecting bolt points shall be matchmarked

in this starting position and all bolts in the joints relevant specifications for the bolt length and type of connection proceeding in an orderly fashion from the most rigid portion of the joint, towards the free edges.

If the finger-tight condition is used as a starting point extra full turns shall be taken to correspond to one-half turn from the snug tight position.

Load indicating bolts or load indicating washers may be used if so approved by the Employer's Representative in writing.

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

5A.6.4.8 Welding

Electrodes for shielded-arc manual welds shall comply with the requirement of IS: 814, and shall be approved make.

The electrodes for manual arc welding shall be suitable for use in the position and type of work, as laid down in the above specifications and as recommended by the manufacturers. Electrodes classification group 1 or 2 as given in IS: 814 shall be used for welding steel conforming to IS: 2062 and electrodes shall conform to IS: 1442 for steel conforming to IS: 8500. Joints in materials above 20 mm thick and all-important connections shall be made with low hydrogen electrodes.

The wire and flux combination for submerged arc welding shall conform to the requirements for the desired application as laid down in IS: 3613. The weld metal deposited by the submerged arc process shall have mechanical properties not less than that specified by the relevant standard.

Electrodes flux covering shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Covered electrodes for manual-arc welding shall be properly stored in an oven prior to use in a manner recommended by the manufacturer and only an hour's quota shall be issued to each welder from the oven.

Electrodes larger than 5 mm diameter shall not be used for root-runs in butt welds.

Welding plant and accessories shall have capacity adequate for the welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality and shall be inspected and approved by the safety officer. The Contractor shall maintain all welding plant in good working order. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided.

All welds shall be made only by welders and welding operators who have been properly trained and previously qualified by tests to perform the type of work required as prescribed in the relevant applicable standards.

All welds shall be free from defects like blow holes, slag inclusions, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, feathered edges without overlap and freedom from porosity.

Fusion faces and surfaces adjacent to the joint or a distance of at least 50 mm on either side shall be absolutely free from grease, paint, loose scales, moisture or any other substance which might interfere with welding or adversely affect the quality of the weld. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations, etc. Preparation of fusion faces shall be done in accordance with the

approved fabrication drawings by shearing, chipping, machining or machine flame cutting except that shearing shall not be used for thickness over 8 mm.

In the fabrication of cover-plated beams and built-up members all shop splices in each component part shall be made before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

Members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated by more than 3 mm. If the separation is 1.5 mm or greater the fillet weld size shall be increased by the amount of separation. This shall only apply in the case of continuous welds. The fill-up of joints at contact surfaces which are not completely sealed by welds shall be close enough to exclude water after painting.

The separation between the two surfaces of lap joints and butt joints with backing plate shall not exceed 1.5 mm. Abutting parts to be butt welded shall be carefully aligned and the correct root gap maintained throughout the welding operation. Misalignments greater than 25 % of the thickness of the thinner plate or 3mm, whichever is smaller, shall be corrected and in making the correction the parts shall not be drawn into a slope sharper than 2° (1 in 27.5).

Pre-qualified welding procedures recommended by appropriate welding standards and known to provide satisfactory welds shall be followed. A welding procedure shall be prepared by the Contractor and submitted to the Employer's Representative for approval before start of welding. This shall include all details of welding procedures with reference to provisions of IS: 9595 and IS: 4353.

Approval of the welding procedure by the Employer's Representative shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

Submerged arc, automatic or semi-automatic welding shall generally be employed. Only where it is not practicable to use submerged arc welding, manual arc welding may be resorted to or as advised by the Employer's Representative based on the Site Condition.

Voltage and current (polarity of direct current is used) shall be set accordingly to the recommendations of the manufacturer of the electrode being used and suitability of thickness of material, joint form etc.

The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided.

No welding shall be done when the surface of the member is wet, not during periods of high wind unless the welding operator and the work are properly protected.

In joints connected by fillet welds, the minimum sizes of single fillet welds or first runs and minimum full sizes of fillet welds shall conform to the requirements of IS: 816 and IS: 9595.

All complete penetration butt welds made by manual arc welding, except when produced with the aid of backing material or welded in flat position, from both sides in square-edge material not over 8mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross section.

Butt welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where abutting parts are 20 mm or more than in thickness, run-on and run-off plates with similar edge preparation and having a width not less than the thickness of the thicker part joined shall be used. These extension pieces shall be removed upon completion of the weld end, the ends of the weld made smooth and flush with the abutting parts. Where the abutting parts are thinner than 20 mm, the extension pieces

may be omitted but the ends of the butt welds shall then be chipped or chiselled gouged out to sound, metal and side welded to fill up the ends to the required reinforcement.

Each layer of a multiple layer weld except root and surface runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

No welding shall be done on base metal at a temperature below 5°C. Base metal shall be preheated to the temperature given in the table below prior to tack welding or welding. When base metal not otherwise required to be preheated, is at a temperature below 0°C, it shall be preheated to at least 20°C prior to tack welding or welding. Preheating shall bring the surface of the base metal within 75 mm of the point of welding to the specified preheat temperature, and this temperature shall be maintained as minimum inter pass temperature while welding is in progress.

Thickness of the thickest part at point of welding	Minimum preheat & inter pass temperature			
	Other than low-hydrogen welding electrodes		Low hydrogen welding electrodes	
	IS: 2062 Steel	IS: 8500 Steel	IS:2062 Steel	IS: 8500 Steel
Up to 20 mm incl.	None	Welding	None	10°C
Over 20 mm to 40 mm incl.	65°C	With this process not allowed	10°C	65°C
Over 40 mm to 63mm incl.	110°C		95°C	not
Over 63 mm	150°C		110°C	150°C

Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 75 mm and above.

Before commencing fabrication of a member or structure in which welding is likely to result in distortion and/or locked up stresses, a complete programme of fabrication, assembly and welding shall be made and submitted to the Employer's Representative for approval. Such a programme shall include, besides other appropriate details, full particulars in regard to the following:

- proposed pre-bending in components such as flanges and pre-setting of joints to offset expected distortion.
- Make up of sub-assemblies proposed to be welded before incorporation in final assembly.
- Proposed joint forms, classification of work and flux or covered electrodes, welding process including fitting and welding sequence with directions in which freedom of movement is to be allowed.
- Proposed number, spacing and type of strong backs, details of jigs and fixtures for maintaining proper fit up and alignment during welding.
- Any other special features like assembling similar members back to back or stress relief.

So desired by the Employer's Representative, mock up welding or sample shall be carried out at the Contractor's cost to establish the efficiency of the proposed programme, with any modification suggested

by the Employer's Representative, in limiting distortion and / or residual stress to acceptable levels. Such modification will not relieve the Contractor of any of his responsibilities,

5A.6.4.9 Inspection of Welds

All welds shall be inspected for flaws as described elsewhere under "Inspection".

In case the tests uncover defective work, the Contractor shall correct such defects at his own cost and prove the soundness of rectified work.

The correction of defective welds shall be carried out as directed by the Employer's Representative without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Employer's Representative shall be used to ensure that the whole of the crack and material 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 Contractor's account.

5A.6.4.10 Tolerances

The dimensional and weight tolerances 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.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

5A.6.5. Inspection and Testing

5A.6.5.1 General

The Contractor shall give due notice to the Employer's Representative in advance of the works being made ready for inspection. All rejected material if with non confirmation report (NCR) shall be promptly removed from the shop and replaced with new material for the Employer's Representative's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Employer's Representative if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer 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 Employer's Representative unless such inspection is waived in writing by the Employer's Representative.

The 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 Employer's Representative.

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

5A.6.5.2 Material Testing

If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

5A.6.5.3 Tests on Welds

All test shall be carried out under the Supervision of the Quality control engineer, Safety Officer and the Employer's Representative shall be approved for the weld thickness

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 Employer's Representative.

Liquid Penetrant Inspection

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

Radiographic Inspection

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

5A.6.5.4 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 Contractor's approved fabrication drawings.

5A.6.5.5 Test Failure

In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the Employer's Representative. The Contractor must obtain permission from the Employer's Representative before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Employer's Representative.

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

The Contractor shall maintain records of all inspection and testing which shall be made available to the Employer's Representative.

5A.6.6. 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 Employer's Representative. All these shop assemblies shall be carried out by the Contractor.

5A.6.7. 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.

5A.6.8. 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 Employer's Representative as defective workmanship. Where the Employer's Representative rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to these Employer's Requirements by the Contractor, at no cost to the Employer. All work shall be inspected and justified and certified by the Client or by the Employer representative

5A.6.9. Site Operations / Temporary facilities

The Contractor shall complete all preliminary works at site both temporary and permanent facilities well before the arrival of structural steel, such as establishment of a well-equipped and adequately staffed site office, stores, unloading gantry, unloading 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 on site.

The Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work well inspected and certified by the Safety Officer and if necessary certified by the Third party certification for periodical safety inspection of the Equipment and Machinery that is used for lifting with well trained and certified rigger and shall remove and take them away after completion of the job. The Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of the Employer's Representative 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 the Contractor's electrical equipment and connections.

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

If a portion of the work of the project area cannot be made available to the 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. The Contractor shall work in co-ordination with other

agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

5A.6.10. Acceptance of Steel, its Handling & Storage

The 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 the Employer's Representative.

No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage and Corrosion . It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by the Contractor well before such excavation and / or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with these Employer's Requirements for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust / corrosion by suitable primer oxide coating and also from damage. If any corrosion found shall be rectified by removing with approved chemicals or by sand paper rubbing or by machine Emery Sheet, Sand Blasting or rust bond coat or as instructed by the Quality control engineer

5A.6.11. Anchor Bolts & Foundations

The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts / foundation shall be reported to the Employer's Representative.

Levelling 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 or as specified in the Approved Drawing . 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 the Contractor at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

5A.6.12. Assembly & Connections

Field connections may be effected either by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the approved design and erection drawings.

All field connection work shall be carried as per the drawings prepared by the Contractor. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor.

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 normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified up to the satisfaction of the Employer's Representative.

Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection and shall be within the tolerance. 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 the Employer's Representative.

5A.6.13. Erection

All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc., unless so permitted by the Employer's Representative in writing. Care shall be taken to see that ropes in use are always in good condition checked and approved by the Safety Officer .

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 or floor.

Structural steel frames shall be erected plumb and true under the supervision of the Safety officer . Frames shall be lifted at points such 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 approved by the Employer's Representative. 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 and strength of the area is also maintained due to splicing and the area is to the Quality Control Employer's Representative Satisfaction . 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 drawings .
- (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 and shall be Inspected as well as approved by the Safety engineer and approved by the Quality Control Engineer for the works.

No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the Employer's Representative. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the Employer's Representative.

For all the above works Test certificates shall be furnished by the Contractor to the satisfaction of the Quality Control Engineer and to the Employer's Representative in charge and also for the machineries

and equipment's Inspection certificate shall be produced with valid License to the Safety Engineer requirements

5A.6.13.1 General

The Employer's Representative shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and re-erection required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the Employer's Representative. All Risk and safety precautions shall be borne by the Contractor and there shall be no fall, incident or accident pertaining to safety laws. Special care and special supervisors and riggers and supporting staffs, workers and approved certified and licence holders will be allowed especially for Hot work and for heavy lifting materials with lifting and erecting machineries and equipment's. All safety warning tapes and barricading and isolation of the work area shall be done and checked by safety engineer and all alarm shall be checked before the commencement of the work. All records for inspection approved shall be maintained.

5A.6.14. Tolerances

5A.6.14.1 General

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. All tolerance shall be as per IS codes Standards and also as per National Building code

5A.6.14.2 Columns

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

- | | | |
|-----|---|-----------------|
| (a) | In longitudinal direction up to full length | ± 3 to 5 mm |
| (b) | In lateral direction | ± 3 to 5 mm |

Deviation in the level of bearing surface of columns at foundation

top with respect to true level	± 5 mm
--------------------------------	------------

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

- | | | |
|-----|---|---|
| (a) | For columns up to and including 15 metres in height | $\pm 1 / 1000$ of column height in mm
or ± 15 mm whichever is less |
| (b) | For columns exceeding 15 metres in height less | $\pm 1 / 1000$ of column height in mm
or ± 15 mm (maximum 20 mm whichever is less) |

Deviation in straightness in longitudinal and transverse planes of column at any the height	$\pm 1 / 1000$ of column height in mm or ± 5 mm or Maximum 10 mm point along the height
---	--

Difference in erected position of adjacent pairs of columns along length or across	± 10 mm
--	-------------

width of building prior to connecting trusses / beams with respect to true distance

Deviation in any bearing or seating level ± 5 mm

with respect to true level

Deviation in differences in bearing level ± 10 mm

of a member on adjacent pair of columns both across and along the building

5A.6.14.3 Trusses And Beams

Shift at the centre of span of top chord $\pm 1/250$ of height of truss in mm

member with respect to the vertical plane or ± 15 mm whichever is less

passing through the centre of bottom chord

Lateral shift of top chord of truss at the $\pm 1 / 1500$ of span of truss in mm

centre of span from the vertical plane or ± 15 mm whichever is less

passing through the centre of supports

of the truss

Lateral shift in location of truss from its ± 10 mm

true vertical position

Lateral shift in location of purlin true ± 5 mm

position

Deviation in difference of bearing i) \pm maximum 20 mm for trusses

levels of trusses or beams from ii) For beams :

the true difference Depth < 1800mm : ± 6 mm

Depth > 1800mm : ± 10 mm

Deviation in sag in chords and diagonals $1/1500$ of length in mm or

of truss between node points 10mm whichever is smaller

Deviation in sweep of trusses, beams etc. $1/1000$ of span in mm subject

in the horizontal plane to a maximum of 10 mm

5A.6.14.4 Crane Girders & Rails

Shift in the centre line of crane rail with ± 5 mm

respect to centre line of web of crane girder

Shift in plan of alignment of crane rail with ± 5 mm

respect to true axis of crane rail at any point

Difference in alignment of crane rail in plan ± 1 mm

measured between any two points 2 metres
apart along rail

Deviation in crane track with respect to

Time gauge

(a) For track gauges up to and

Including 15 metres ± 5 mm

(b) For track gauges more than $\pm [5 + 0.25 (S-15)]$

15 metres where S in metres is true gauge

Deviation in the crane rail level at any $\pm 1/1200$ of the gauge distance or

point from true level ± 10 mm whichever is less

Difference in the crane rail actual levels ± 2 mm

between any two points 2 metres apart along the rail length

Difference in levels between crane track Rails at

(a) Supports of crane girders ± 15 mm

(b) Mid span of crane girders ± 20 mm

Relative shift of crane rail surfaces at a 2 mm subject to grinding of
joint in plane and elevation surfaces for smooth transition

Relative shift in the location of crane 1/1000 of track gauge S in

stops (end buffers) along the crane tracks mm subject to maximum

with track gauge S in mm of 20 mm

5A.6.15. Clean up of Work site

During erection, the Contractor shall 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 the Employer's Representative, and Completion also all the work shall be cleaned and Inspected by the Quality Control Employer's Representative

5A.6.16. Painting

5A.6.16.1 General

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. 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 and Inspected and approved by the Quality Control Employer's Representative.

5A.6.16.2 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 workmanship shall generally conform to the requirements of IS 1477- Part I. and thickness of the paint for wet film thickness shall be checked by the approved Instrument and Inspected and approved by the Quality Control Engineer.

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 pelt or salts, the cleaning shall be done with strong alkalis. After cleaning, water rinsing and subsequent passivation by dilute chromic acid rinsing shall be carried out to ensure that no traces of alkali is left on the surface. The procedure for cleaning by above mentioned methods shall be as per manufacturer's instructions.

De-rusting 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, 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 treatment shall have been cleaned of dust and grease and heavier layers of rust 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 heating 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 only be carried out 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 due 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 2.5 or Sa 3 as per Swedish Standard SIS-05-5900 as required or as per National Occupational standards.

As sand blasting causes dust pollution , necessary clearance shall be obtained by the Contractor from the 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.

All surfaces shall be cleaned thoroughly as per manufacturers specification before application of primer.

5A.6.16.3 Materials

Primer paint

Anti-corrosive primers shall be either lead based or lead free types. Red lead primer shall conform to IS 102 and red oxide zinc chrome primer shall conform to IS 2074.

Finish Paint

Epoxy primer and epoxy paint shall be of the type as specified 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. The Contractor shall obtain prior approval of the Employer's Representative 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 colour and shade shall be conforming to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade number from the alternatives available, the Contractor shall adopt trial painting in small patches in consultation with and as approved by the Employer's Representative.

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 approved so by the Employer's Representative.

Paints shall be stirred thoroughly to keep the pigment in suspension.

The Contractor shall arrange for testing of paints as per relevant Indian Standards in an approved laboratory whenever the Employer's Representative requires the tests to be carried out for each batch of paints. Test results shall be submitted to the Employer's Representative for approval. All layer by layer painting sample shall be done 2m x 2m sample area for different proposed color and shall be checked for testing 7 days prior to work and shall be Inspected and approved after testing for wet film and dry film thickness by the Quality Control Engineer. Care shall be taken all the works shall be followed as per schedule Plan with the Employer's Representative in charge approval .If any Delay shall be

recovered by Over time and shift system without any Hindrance and paint pollution to adjacent workers and works .All work shall be fully Inspected and approved for safety precautions by the Safety Engineer .

5A.6.16.4 Workmanship

The type and the number of coats of the primer paint and finish paint shall be as specified.

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 5deg.C or lower. All painting shall be done as per IS codes and under justified temperature under the Complete supervision of Quality Control Engineer.

Primers shall adhere to the surface firmly and offer a key to the subsequent coats.

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 or by spraying and working it well to ensure a continuous film. After the first coat becomes hard dry a second coat of primer shall be applied by brushing or by spraying .

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 or as per site Instruction from the Quality Control Engineer.

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 of 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 (finely powdered calcium carbonate) and linseed oil by craftsmen at site shall not be used. 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, 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 undercoats also.

Painting shall be carried out either by brushing or by spraying. The Contractor shall procure the appropriate quality of paint and well inspected brush 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 or nil 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 application of successive coats or as recommended by the Site Instructions. Each coat shall be approved by the Employer's Representative, prior to applying the next coat.

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 the Elcometer at any time.

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 at least 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, peeling, blistering and rusting. 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 – Part II.

The Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls, etc. and all painting shall be checked and measured as per Site recommendation and few are recommended and suggested below by different gauges

1. Magnetic Film Thickness Gauges. ...
2. Magnetic Pull-off Thickness Gauges. ...
3. Magnetic and Electromagnetic Induction Instruments. ...
4. Eddy Current Thickness Gauges. ...
5. Ultrasonic Thickness Gauges. ...
6. Micrometer Thickness Gauges. ...
7. Destructive Tests. ...
8. Gravimetric Thickness Gauges.

5A.6.17. 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. Contractor shall submit to Employer 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. One tonne for the purpose of payment shall mean One Metric Ton i.e. 1000 kg (kilo gram) .

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 hole, 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 or as per Site Employer's Representative's recommendation . 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 All measurement for gusset plat shall be as per approved drawings or Shop drawings and as per the Recommendation of the Employer's Representative in charge .

For gussets / plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated 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 grinded and finished smooth. No extra payment shall be made for such plug welding.

Painting work shall not be measured separately, if primer painting and / or primer and finish painting is deemed to be included in the scope of the item of work of fabrication and erection of structural steel since the rate per tonne of steel is deemed to include for painting as specified.

In cases where primer and /or finish painting work as specified is carried out on erected structural steel executed by a different agency, the method of measurement for painting shall be on the basis of tonnage of steel erected. For this purpose, the tonnage of erected steel as certified for payment to the different agency shall be considered as the basis and no measurement will be carried out separately. All Measurements shall be carried along with the Employer's Representative in charge and the Quantity Surveyor with the approved test certificates of the Quality Control Engineer .

5A.6.18. Galvanising of Structural Steel**5A.6.18.1 Galvanising Plant**

Prior approval shall be obtained from Employer / Employer's Representative if galvanising is proposed to be carried out outside Contractor's plant.

5A.6.18.2 Workmanship

After all shop work is complete, all structural materials shall be punched with the erection mark and be hot-dip galvanised. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality

and durability of the zinc coating. Pickling shall be very carefully done and shall be with proper care without any damage .

The weight of the zinc coating shall be at least 0.610 kg / sq.m unless specified otherwise. Stub members and members for grillage type footing shall have heavier zinc coating not less than 0.80 kg / sq.m.

The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel, globules, spiky de S:2633 unless specified otherwise.

All galvanised members shall be treated with Sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However, in case of members over 7.5 M long, the Contractor shall take prior approval of Employer's Representative for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed by 'bumping' or as per Recommendations.

Wherever galvanised bolts, nuts locknuts, washers, accessories etc. are specified, they shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanising shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications, or lack of quality control in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.

Contractor shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damages Contractor shall at his own cost adopt scrapping and reglvanising the member to satisfy the specific requirements. Special Care is taken for the Safety precautions during Galvanizing .

5A.7 - WATER SUPPLY AND SANITARY WORKS

5A.7.1. Applicable Codes

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

IS : 210	:	Specification for grey iron castings
IS : 269	:	Specification for 33 grade ordinary 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 wire for concrete reinforcement (Part-I & II)
IS : 456	:	Code of Practice for plain and reinforced concrete
IS : 458	:	Concrete Pipes (with and without reinforcement).
IS : 516	:	Methods of tests for strength of concrete
IS : 554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 651	:	Salt glazed stoneware pipes and fittings.
IS : 774	:	Flushing Cisterns for water closets and urinals (valveless siphonic type)
IS : 781	:	Sand-cast brass screw-down bib taps and stop taps for water services.
IS : 783	:	Code of practice for laying of concrete pipes.
IS : 1068	:	Electroplated coatings of nickel and chromium of iron and steel.
IS : 1077	:	Specification for common burnt clay building bricks
IS : 1239	:	Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
IS : 1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS : 1703	:	Copper Alloy float valves (horizontal plunger type) for water supply purposes.
IS : 1726	:	Cast iron manhole covers and frames.
IS : 1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1742	:	Code of practice for buildings drainage
IS : 1786	:	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 2116	:	Specification for sand for masonry mortars
IS : 2212	:	Code of practice for brickwork
IS : 2250	:	Code of practice for preparation and use of masonry mortars
IS : 2326	:	Automatic flushing cisterns for urinals

IS : 2470	:	Code of practice for design and construction of septic tanks (Parts I & II)
IS : 2556	:	Vitreous sanitary appliances (Part I to Part XV)
IS : 2963	:	Specification for copper alloy waste fittings for wash basins and sinks
IS : 3006	:	Specification for chemically resistant glazed stoneware pipes and fittings
IS : 3311	:	Waste plug and its accessories for sinks and wash basins
IS : 3495	:	Methods of tests of burnt clay building bricks
IS : 4111	:	Code of practice for ancillary structures in sewerage system manholes
IS : 4127	:	Code of Practice for laying of glazed stoneware pipes
IS : 5329	:	Code of practice for sanitary pipe work above ground for buildings
IS : 5382	:	Specification for rubber sealing rings for gas mains, water mains and sewers
IS : 5455	:	Specification for cast iron steps for manholes

5A.7.2. Sanitary Installation

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

All sanitary and plumbing work shall be carried out by licensed plumbers.

All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Employer's Representative.

All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, 'P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.

Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

5A.7.3. Indian Type Water Closet

This shall be the long pan pattern with separate footrests made of white glazed earthenware, white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS:2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Employer's Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap 'P' or 'S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

5A.7.4. European Type Water Closet

Water closets shall be either of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic / Bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an anti siphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed and shall have minimum 6 litres at low level .

5A.7.5. Urinals

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

5A.7.6. Wash Basins

Wash basins shall be of white or approved colour glazed earthenware, white glazed vitreous china or white glazed fire clay or as approved by the Employer's Representative and conforming to IS.2556

Type	Size
Flat Back	630 x 450 mm
Flat Back	550 x 400 mm

Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each shall have a rim sloping inside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the under side of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not

less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.

All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

5A.7.7. Sinks

The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:

450 x 300 x 150 mm

600 x 450 x 200 mm

They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

5A.7.8. Flushing Cisterns

The flushing cisterns shall be automatic or manually operated, high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS.774. Automatic flushing cistern for urinals shall conform to IS.2326.

5A.7.9. Cast Iron Soil Waste and Vent Pipes and Fittings

All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS.1536. The diameter approved shall be internal diameter of pipe. The pipes and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign material before being fixed.

All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by M.S. holder bat clamps, unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakages shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45°. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag or jute cloth and kept moist. Joints shall be perfectly air tight as well as water tight.

C.I. pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required colour to get the approved shade shall be given over the base primer coat.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions approved for the corresponding sizes of straight pipes.

The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm dia. puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.

All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Employer's Representative and left in working condition after completion. The smoke test shall be carried out as stated under :

Smoke shall be pumped into the pipe at the lowest end from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline.

Water test and air test shall be conducted as stipulated in IS.5329.

5A.7.10. Steel Pipes

The pipes shall be steel pipes and seamless screwed and sockets tubes conforming to the requirements of IS.1239, for medium grade. They shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS:554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS:554.

Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for

turning of the threads so as to make them slack, water tight joint. The screw- thread of pipes and fittings shall be protected from damage until they are fitted.

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the Pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.

Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Employer's Representative.

G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.

The work of excavation and backfilling shall be done true to line and gradient in accordance with general Employer's Requirements for earthworks in trenches for pipes laid underground.

The pipes shall be laid on a layer of 10.0 cm sand and filled upto 15 cm above the pipes. A sand cushion of 15cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. when excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Employer's Representative and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully filled / charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped, the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor.

The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter

installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

5A.7.11. Stoneware pipes and fittings

All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade 'A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

The following information shall be clearly marked on each pipe and fitting :

- (a) Internal diameter;
- (b) Grade;
- (c) Date of manufacture;
- (d) Name of manufacturer or his registered trade-mark or both.

All pipes and fittings shall have ISI mark.

Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant IS. After jointing, extraneous material if any, shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS : 5382.

5A.7.11.1 Spigot and Socket Joint (Cement Joint)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one-fourth of the depth of socket.

Cement mortar (1:1) (sand shall be fine sand) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees. The cement mortar joints shall be cured at least for seven days before testing. The approximate quantity of cement required for each joint for certain common sizes of pipes are given below for guidance :

Nominal diameter of pipe (mm)	Cement (kg)
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5

5A.7.11.2 Spigot and Socket Joint (Bituminous Joint)

The general requirements for this type of joint shall be as specified in 13.12.1 The material for jointing shall consist of composition of asphalt and sand in the ratio of 1:7. Asphalt and sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

5A.7.11.3 Spigot and Socket Joint (Rubber Ring Joint)

The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS : 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

5A.7.11.4 Cleaning of Pipes

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Employer's Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Employer's Representative to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction the Employer's Representative considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be tested immediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Employer's Representative.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Employer's Representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer's Requirements and as approved by the Employer's Representative. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Employer's Representative. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Employer's Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The tolerance of two litres per Centimetre of diameter per kilo meter may be allowed during a period of 10 minutes. Any

leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed or rectified as per site condition and made good.

If any damage is caused to the pipeline during the execution of work or while cleaning / testing the pipeline as specified. The Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Employer's Representative.

Water for testing of pipeline shall be arranged by the Contractor.

5A.7.12. Stop Cock and Bib Cock

A bibcock (bib tap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. in finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discoloured.

These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed or flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

5A.8 - GENERAL CIVIL WORKS

5A.8.1. 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 over primers
- 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: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:1397 - Specification for kraft paper
- 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 : Part 1 Rubble stone masonry
- 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: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 waterproofing compounds
- IS:2690 - Specification for burnt clay flat terracing tiles : Part 1 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-asbestos floor tiles
- IS:3462 - Specification for unpacked flexible PVC flooring
- IS:3495 - Method of test for burnt clay building bricks: Part 1 to 4
- IS:3536 - Specification for ready mixed paint, brushing, wood primer, pink
- IS:3564 - Specification for door closers (hydraulically regulated)
- IS: 3614 - Specification for fire checks doors : Part –I Plate metal covered and rolling type
- (Part – 1)
- IS: 3614 - Specification for metallic and non-metallic fire check doors : Part-2 Resistance test and performance criteria
- (Part – 2)
- IS:3696 - Safety code of scaffolds and ladders (Parts 1 & 2)
- 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 door frames
- 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:12200 - Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams
- BS : 476 - Methods for determination of the fire resistance of elements of construction
(Part – 20) (General Principles)
- BS : 476 - Methods for determination of the fire resistance of load bearing elements of
(Part – 21) construction
- BS : 476 - Methods for determination of the fire resistance of non-load bearing elements
(Part – 22) of construction
- Part – IV - National Building code of India (Fire Protection)

5A.8.2. Brickwork

5A.8.2.1 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.

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.

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. 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.

5A.8.2.2 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. 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 utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs upper side mostly.

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 levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least 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 x 115mm x 75mm, 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 de-shuttered 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 transoms and mullions of dimensions as indicated in the construction Drawings are generally required to be provided in the half brick partition walls.

Where the drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20 mm 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.

Contractor shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and provide pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Miscellaneous inserts shall be either supplied free by the Employer or to be furnished by the Contractor. Any of the miscellaneous inserts which are required to be fabricated and supplied by the Contractor and

cement concrete to be provided in the pockets for holdfasts of door / window frames etc. shall however, be measured and paid for separately under the respective items of work.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the drawings 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. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

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

5A.8.2.3 Measurement

Measurement shall be in cu. m correct to two places of decimal for brickwork of thickness one brick i.e. 200 mm/230 mm and above. Measurement shall be in sq. m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms / mullions etc. All concrete works shall be measured and paid for separately under the respective items of work.

5A.8.3. Uncoursed Random Rubble Masonry in Foundation, Plinth and Superstructure

5A.8.3.1 Materials

Stones for the works shall be of the specified variety which is 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 5A.8.2.1.

5A.8.3.2 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 up to 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 up to 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 or as per approved shop drawing .

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 / Wet work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist after 24 hrs of work 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 clause 5A.8.2.2.

5A.8.3.3 Measurement

Measurement shall be in cu.m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

5A.8.4. Coursed Rubble Masonry (First Sort) for Superstructure

5A.8.4.1 Materials

The Material specification for the work shall be as per clause 5A.8.3.1.

5A.8.4.2 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 at least 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 at least 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 at least 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 pinning's 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 wet / 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 5A.8.3.2 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 Clause 5A.8.2.2.

Requirements of execution of the work and curing shall be as stipulated in clause 5A.8.3.2 .

5A.8.4.3 Measurement

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

5A.8.5. Concrete Block Masonry

5A.8.5.1 Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS : 2185 (Part 1). Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS : 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part 3).

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.

5A.8.5.2 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 5A.8.2.1.

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, levelled 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 Mortar 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 as per the drawings.

For jambs of doors, windows and openings, solid 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 laid up at the same time with a true masonry bond between at-least 50% of the concrete blocks. The sequence for construction of partition walls and treatment the top of load bearing walls for the RCC slab shall be as detailed under clause 5A.8.2 for the brick work.

Curing of the mortar joints shall be carried out for at-least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 5A.8.2.2 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.

A special type well burnt clay block called Hourdi Block for certain case of work shall be used if approved and recommended shall be used as per Employer's Representatives instruction Definition is Hourdi blocks are made from natural clay that is baked in a kiln to create a hard, hollow component of the roof. ... The Hourdi Block is lighter in weight, speeds up the construction process and eliminates the need for shuttering as compared to the conventional Reinforced Cement Concrete system.

5A.8.5.3 Measurement

Measurement shall be in cu. m. correct up to two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq.m correct upto two places of decimal for walls of 100 mm/150 mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings and concrete works. Concrete and reinforcement will be measured and paid for separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

5A.8.6. Damp - Proof Course

5A.8.6.1 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 down graded coarse aggregates.

The surface of brick work/stone masonry work shall be levelled 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 at least seven days after which it shall be allowed to dry for taking up further work.

5A.8.6.2 Measurement

Measurement of damp-proof course shall be in sq.m correct to two places of decimal as actually executed. No separate payment will be made for formwork.

5A.8.7. Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedment and corner angles etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction drawings. Contractor shall prepare and use templates and shop drawings 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 without any extra cost to the Employer.

5A.8.7.1 Miscellaneous Inserts, Bolts etc.

Miscellaneous inserts, supplied by the Contractor shall be measured and paid for as per the respective items of work.

5A.8.8. Wood Work in Doors, Windows, Ventilators & Partitions

5A.8.8.1 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 planned 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.

5A.8.8.2 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 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 smooth planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon 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. 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. The stiles and rails shall be joined by mortice and tenon 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 in the item of work.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminium shall be as specified. The number, size and type of the fittings and fixtures shall be as indicated in the drawings/item of work.

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.

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

The framework of the partitions with mullions and transoms 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.

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 Specifications at no extra cost to the Employer.

5A.8.8.3 Measurement

Measurement for doors, windows, ventilators, architraves and partitions shall be in sq.m correct to two places of decimal. Handrailing shall be measured in running metres correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for all the works including glazing, painting, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

5A.8.9. Steel Doors, Windows and Ventilators

5A.8.9.1 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.

5A.8.9.2 Workmanship

All steel doors, windows and ventilators shall be of the type as specified in the respective items of work and of sizes as indicated in the drawings. 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 for single or composite units.

For windows with fly proof mesh as per the item of work, 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. 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.

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 all-round the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited. All doors and windows shall be as per site condition and also matching to the approved Drawing or detailed /Shop drawing .

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. 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.

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

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. The number, size and type of fittings and fixtures shall be as in the Drawings /items of work.

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.

5A.8.9.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out to out of the frames. Rates quoted shall be for the works including glazing, painting, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

5A.8.10. Aluminium Doors, Windows, Ventilators & Partitions

5A.8.10.1 Materials

Aluminium 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.

5A.8.10.2 Workmanship

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

All aluminium 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, aluminium sliding windows, partitions shall be as described in the items of work / drawings.

IS:1948 and IS:1949 refers to incorporating the sizes, shapes, thicknesses and weight per running metre of extruded sections for various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are 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 / specified in the items of work.

The framework of the partitions with mullions and transoms shall be with anodised aluminium box sections. Anodised 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. 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.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 5A.8.9.2 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. 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.

5A.8.10.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be from out of the frames. Rate quoted shall be for the works including glazing, Builder's hardware of fittings and fixtures as specifically described in the respective items of work.

5A.8.11. Steel Rolling Shutters

5A.8.11.1 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 up-to 12 sq.m, gear operated type (mechanical) for clear areas up-to 35 sq.m and electrically operated type for areas up- to 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.

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 and as per manufacturer recommendation .

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 work.

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 per sq.m shall be as specified in the items of work.

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.

5A.8.11.2 Measurement

Measurement shall be in sq.m correct to two places of decimal of the clear area of the opening. Quoted rate shall be inclusive of painting as specified in the item of work.

5A.8.12. Rubble Sub-Base**5A.8.12.1 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 neither 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.

5A.8.12.2 Workmanship

Stones shall be free of organic sticking on the surface and 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.

5A.8.12.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

5A.8.13. Base Concrete

The thickness and grade of concrete and reinforcement shall be as specified in items of work.

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.

5A.8.13.1 Measurement

Measurement shall be in sq.m correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work

5A.8.14. Terrazzo and Plain Cement Tiling Work

5A.8.14.1 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/mm².

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

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.

5A.8.14.2 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 at-least 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. Contractor shall note that the unit rate quoted for skirting shall also include for any chipping of the brickwork required to be carried out for this item.

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 $\pm 3\text{mm}$ in any 3m length is acceptable in a nominally flat floor.

5A.8.14.3 Measurement

Measurement for floor tiling and dado shall be in sq. m correct to two places of decimal. Actual quantity of tiling work as laid shall be measured for payment as per the respective items of work after making deductions for openings etc. Measurement for skirting shall be in running metres correct to two places of decimal for the specified height as per the item of work.

5A.8.15. In-Situ Terrazzo Work

5A.8.15.1 Materials

The requirements of marble aggregates for terrazzo topping shall be as per clause 5A.8.14.1.

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.

5A.8.15.2 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. 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 underlayer shall be of cement concrete of mix 1:2:4 using 10mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

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 underlayer 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 at least 24 hours between laying adjacent bays.

Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works. Aluminium 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 underlayer, 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 screening board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

Terrazzo topping shall be laid while the underlayer is still plastic and normally between 18 to 24 hours after the underlayer 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 trowelling. 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.

5A.8.15.3 Measurement

Measurement shall be as per clause 5A.8.14.3.

5A.8.16. Kota Stone Slab/ Granite flooring work**5A.8.16.1 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.

5A.8.16.2 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 work.

Dado / skirting work shall be as per clause 5A.8.14.2. 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 clause 5A.8.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not be applied before polishing.

5A.8.16.3 Measurement

Measurement shall be as per clause 5A.8.14.3.

5A.8.17. Carborundum Tile Finish**5A.8.17.1 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.

The size, thickness, colour and plain or chequered etc of the tiles for flooring / skirting shall be as specified in the respective items of work.

5A.8.17.2 Workmanship

Requirements as detailed for terrazzo/cement tile finish under clause 5A.8.14.2 shall be applicable for carborundum tile flooring.

5A.8.17.3 Measurement

Measurement shall be as per clause 5A.8.14.3.

5A.8.18. Glazed Tile Finish**5A.8.18.1 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.

5A.8.18.2 Workmanship

The size, thickness, colour, with or without designs etc of the tiles for flooring /dado/skirting shall be as specified in the respective items of work.

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 at-least 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.

5A.8.19. In-Situ Cement Concrete Floor Topping

5A.8.19.1 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 in the items of work.

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.

5A.8.19.2 Workmanship

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

Preparation of base concrete/structural slab before laying the topping shall be as per clause 5A.8.13. 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 trowelling 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 finish which are difficult to repair satisfactorily.

5A.8.19.3 Measurement

Measurement shall be as per clause 5A.8.14.3.

5A.8.20. In-Situ Granolithic Concrete Floor Topping

5A.8.20.1 Materials and Workmanship

The requirements of materials and workmanship shall be all as per clause 5A.8.19 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.

5A.8.21. Floor Hardener Topping

5A.8.21.1 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.

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 screened and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 5A.8.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for at-least 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.

5A.8.21.2 Measurement

Measurement shall be in sq.m correct to two places of decimal. This could be either separate or combined along with the floor finish as indicated in the respective items of work.

5A.8.22. PVC Sheet / Tile Flooring**5A.8.22.1 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.

5A.8.22.2 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 underbed 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 underbed 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 underbed 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 underbed 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 slide 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.

5A.8.22.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. The item could be either separate or as a combined item with the floor finish as specified in the respective items of work.

5A.8.23. Acid Resisting Brick / Tiling Work

5A.8.23.1 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.

5A.8.23.2 Workmanship

The size and thickness of tiles/size and class of bricks for use in the flooring /skirting / dado shall be as specified in the respective items of work.

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 cashew-nut 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.

5A.8.23.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for flooring/dado. Measurement shall be in running metres correct to two places of decimal for skirting of height as specified in the item of work.

5A.8.24. 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.

5A.8.25. Epoxy Lining Work

5A.8.25.1 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 upto 60deg.C
- d) Ultraviolet 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.

5A.8.25.2 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 days of laying of the lining.

5A.8.25.3 Measurement

Measurement shall be in sq.m correct to two places of decimal.

5A.8.26. Polyurethane Coating**5A.8.26.1 Material**

100% solids polyurethane coatings usually consist of two components: one isocyanate-rich solution and one polyol-rich solution. This has been defined in ASTM D16 Type V. Such a polyurethane coating film is formed when the above mentioned components are combined; a rapid and exothermic chemical polymerization reaction takes place. These two components are mixed in 1:1 solution.

By definition, the term "100% solids" means the coating system does not use any solvent to dissolve, carry or reduce any of the coating resins. Further, the resins normally still in a liquid state, will convert, 100%, to a solid film after application. The viscosity of the coating system is determined by the selection and design of the resin components. It is not determined by the addition of a solvent.

The properties of 100% solids polyurethanes vary from very soft, rubbery elastomers (like running shoe soles) to hard, ceramic like systems. The elastomers have a more linear structure with much less cross linking that allows them to be very stretchy and elastic. These systems normally have great impact strength and flexibility.

5A.8.26.2 Workmanship

The minimum thickness of polymer coating shall be 500 micron. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the polymer coating is proposed.

This polyurethane coating is applied with a two component plural gun air less spray equipment. For RCC wall, one coat of moisture cured polyurethane primer is applied over the concrete surface. Over

this primer, required coats of 100% Solid Elastomeric Polyurethane are applied. If the substrate is exposed to sun, one coat of Polyurethane aliphatic finish coat is applied.

For Elastomeric Polyurethane coat, it is required to use a two component airless spray gun equipment. The spray pumps are operated on hydraulic pressure.

For other coats of Moisture Cured Polyurethane, any standard spray equipment or brush application is OK.

5A.8.27. Water-Proofing

Machine made flat Yelahanka tiles shall be of the size and thickness as specified in the item of work. Tiles shall be soaked in water for at-least one hour before laying. The tiles shall be laid on a mortar bed of cement mortar 1:3 with an average thickness of 25mm. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and to set to plane surface true to slope, using 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 on 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 at-least 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:3 mixed with red-oxide. Curing shall be carried out for a minimum period of seven days.

5A.8.27.1 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.

5A.8.27.2 Modified Bituminous Membrane

Modified Bituminous Membrane shall be "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 thermo fusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited. "PLYFLEX" of Bitumat Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent IS specification.

5A.8.27.3 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 or otherwise as indicated in the drawings.

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. 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 smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar/ jaggery 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 at-least 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 the paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

5A.8.27.5 Waterproofing of Roofs / Terraces etc.

(a) 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 Employer's Representative-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 anti glows reflective paint.

(b) 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 upto a pre-cut chase anchored and sealed.

5A.8.27.6 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.

5A.8.27.7 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.

5A.8.28. Cement Plastering Work**5A.8.28.1 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 Specifications. 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.

5A.8.28.2 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 wet/ 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 at-least 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 at-least 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 at least 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 wet/ green to obtain as far as possible a uniform pattern all as directed by the Employer's Representative.

Where specified in the drawings, 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.

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 7 days.

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 after bull marking first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 5A.8.2.2.

The finished plaster surface shall not show any deviation more than 3/4mm 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.

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 background exists.

5A.8.28.3 Measurement

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

5A.8.29. Cement Pointing

5A.8.29.1 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.

5A.8.29.2 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 wet/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 at-least 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.

5A.8.29.3 Measurement

The quantity of work to be paid for under this item shall be measured in sq.m. Correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

5A.8.30. Metal Lath and Wire Fabric

5A.8.30.1 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.

5A.8.30.2 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 spacings not more than 100 mm for lath plastering work. Nailing to wall shall be at spacings 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.

5A.8.30.3 Measurement

Measurement shall be in sq.m correct to two places of decimal for the type as specified in the respective items of work.

5A.8.31. 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.

5A.8.32. Painting of Concrete, Masonry & Plastered Surfaces

5A.8.32.1 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 cum 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.

5A.8.32.2 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.

5A.8.32.3 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.

5A.8.32.4 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.

5A.8.32.5 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.

5A.8.32.6 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.

5A.8.32.7 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.

5A.8.32.8 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.

5A.8.32.9 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.

5A.8.32.10 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc.

5A.8.33. Painting & Polishing of Wood Work**5A.8.33.1 Materials**

Wood primer shall conform to IS: 3536.

Filler shall conform to IS: 110.

Varnish shall conform to IS: 337.

French polish shall conform to IS: 348.

Synthetic enamel paint shall conform to IS: 2932.

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.

5A.8.33.2 Workmanship

The type of finish to be provided for woodwork of painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS: 2338 (Part I).

All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made-up by applying an optimum coat of filler conforming to IS: 110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Employer's Representative. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the Employer's Representative. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flattening varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

5A.8.34. Painting of Steel Work

5A.8.34.1 Materials

Red-oxide – zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932.

Aluminium paint shall conform to IS: 2339.

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 the materials shall be brought to the site in sealed containers.

5A.8.34.2 Workmanship

Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as

recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS: 1477 (Part 2).

The type of paint, number of coats etc. shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part – I) and as indicated in the item of work.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer 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'.

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

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

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

5A.8.35. Flashing

5A.8.35.1 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.

5A.8.35.2 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 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 filleting as indicated in the Drawings. Curing of the mortar shall be carried out for a minimum period of 4 days.

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.

5A.8.35.3 Measurement

Measurement shall be in sq.m correct to two places of decimal. Measurement shall be for the actual area of the flashing material provided and the rate shall include for all the incidental works of bending to shape and fixing details as per the construction drawings.

5A.8.36. Thermal Insulation for Ceiling

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

5A.8.36.1 "Thermo-col" 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.

Thermo-col 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.

5A.8.36.2 Fibre Glass Boards .

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

'Crown' 200 fibreglass 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 wire mesh with 50mm overlap and secured to the timer 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.

5A.8.36.3 Measurement

The net superficial area of the insulation shall be measured and paid for.

5A.8.37. Plaster of Paris Board False Ceiling

5A.8.37.1 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 the 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.

5A.8.37.2 Metal Framework

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.

5A.8.38. 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.

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 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 wall angles.

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 rustles 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 the Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by the Employer's Representative.

5A.8.38.1 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 inter-locking 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 (A QUICK SETTING GYPSUM) (calcium Sulphate hemihydrate powder) 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.

5A.8.38.2 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).

5A.8.38.3 Measurement and Payment

The superficial area of false ceiling shall be measured and paid for at the unit rate less deductions, if any. Openings in false ceiling which are less than 0.4 sq.m. in area shall not be deducted for the purpose of payment.

5A.8.39. False or Cavity Floor

5A.8.39.1 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 prop head.

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 prop head 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 proheads. 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.

5A.8.39.2 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/cum 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 k Cal/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 and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the supporting framework. Each floor panel shall be marked 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.

5A.8.39.3 Finished Height of False Flooring

The finished height from top of reinforced concrete floor to the finished floor surface of false/cavity floor shall be as specified or as shown on drawings.

5A.8.39.4 Ramps and Steps

Ramps and steps shall be provided as shown on the Employer's Representative's drawing and as directed by the Employer's Representative without any extra cost to the Employer.

5A.8.39.5 Imposed Loading

The finished floor shall be capable of supporting a uniformly distributed loads 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.

5A.8.39.6 Finish

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

5A.8.39.7 General

Supply shall be made by a specialist supplier who is to be approved by Employer's Representative. Supplier shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, supplier 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.

5A.8.39.8 Measurement

The superficial area of false floor shall be measured and paid for at the quoted unit rate.

5A.8.39.9 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.

5A.8.40. Fire Proof Doors**5A.8.40.1 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 – I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. 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 or two 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.

PART II EMPLOYER'S REQUIREMENTS

Section VI-5B

SPECIFICATIONS FOR ARCHITECTURAL, LANDSCAPING, FIRE PROTECTION, HVAC AND PLUMBING WORKS

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5B.1 SPECIFICATION FOR ARCHITECTURAL WORKS

5B.1.1 Glazing materials

- Glass pane shall be provided in woodwork as per standard IS:1761(for glazed paneled shutter).
- Glass thickness shall be 2mm for pane upto 1.0 Sqm and 3mm for pane more than 1 Sqm. Tolerance 0.2 mm in both cases.
- All glass panels shall have uniform reflective index and free from flaws, specs and bubbles etc.

5B.1.2 Flushed door shutters

- The door shall be of flush type solid core with single/double shutter.
- Glass Shutters: The shutters shall be decorative type of the exterior or interior grade as suggested in the drawing.
- Grade: I.S. 2002/1983.
- Solid core finished thickness shall be mentioned in the item.

5B.1.3 Fixtures and fastenings

- All fastenings shall be as per drawings, approved by 'PMC'
- Until unless specified by the engineer incharge the material of fixtures and fastenings shall be oxidized brass of good workmanship
- It shall be confirmed to the relevant specifications for the type and given in IS 2202/1983
- Face veneers shall be used, and its pattern color approved by the 'PMC'
- Each door/window shall be furnished with all accessories as shown in the drawings and approved by the "PMC"

5B.1.4 Steel door frames

- Material shall confirm to relevant IS Standard.
- (Tolerance): The dimensions mentioned in the drawing for architecture door frame, shall not vary by +/- 2mm.
- Accessories for the door: Each door frame shall consist of all accessories and fixed mechanically.
- Base Tiles: Mild steel angle of size: 20mm X 20mm X 1.25mm thick, to suit floor thickness of 25, 30, 35 and 40 mm.
- Frame shall be fixed to the R.C.C. Column/Brick Wall, by fixing holdfasts etc.
- Hinges: Frames shall be provided with any one type of the hinges conforming to the relevant Indian Standards.

5B.1.5 MS Grill work:

- M.S. Grills for windows and ventilators, in M.S. Flats and square rods as per approved design, drawings including, cutting steel sections and welding the same to required pattern with a coat of red lead primer.
- Cost of materials of red lead primer, fixtures, labour, machinery as per specifications.

5B.1.6 Glazing, Doors, Windows, skylight, and Atrium works (includes all framing):

- Glazing Systems, Glass
- Glazing accessories shall comply to performance request, shall be provided by the painter.
- Glass thickness shall be designed by the façade sub-contractor but shall not be less than 12mm, or Architect to choose from the catalogue of vendors.
- Alignment on the external side: In case the thickness varies in the same visual pane, the system shall include spacers in order to have alignment on the exterior side.
- Glass Type, Colors, Shade, tint and physical photometric properties shall comply or outperform the bench marks.
- Heat built-up @ shadow boxes and other non – vented spaces shall be considered and provision for same shall be considered.
- Probability of breakage of glass due to anticipated thermal stress in glass shall not exceed (8/1000).

ASTMC 1036: Standard Specification for flat glass.

ASTMC 1048: Standard Specification for heat treated glass.

- All glass should be free from cracks, scratches, bubbles, blisters, all inclusive of deleterious materials including nickel sulphide and other defects, which detract from appearance or interfere with performance.
- All glasses shall have clean, wheel cut edges with minimum feather, free from vents, notches or shells.
- Factory Manufactured ISO-9002:

5B.1.7 Laminated Glass

- Shall be in accordance with AS 2208 and FGMA glazing manual.
- Manufacturers include DuPont

Insulating Glass Unit: (IGU's), also known as double glazed units of accepted types in accordance with ASTM E774, AS 2008. Insulated glass shall have double edge seals. The primary seal between spaces and glass shall be a continuous butyl tape with no skips or voids. IGUs shall incorporate accepted polyisobutylene primary (vapor) seals continuously bonded to glass, and two-part Silicone Secondary (Structural Seals). Primary seal shall not be less than 3mm deep.

5B.1.8 Flooring and allied works: (marble/granite/kotah)

- The stone should have atleast 15% recycled material
- The tiles / stones used shall be procured from the manufacturing plants / quarries located within 400 km from the project site.

5B.1.9 Finishes for stones

- Sawn: Appearance of the stone is a result of blade or wire used to cut it. A sawn finish will produce a flat but raw stone. Primarily used on curbing.
- Honed: The honed finish is smooth and shows the full colors of the stone without any reflections.
- Machine Tooled: (4/6/8): Brush hammered finish consists of parallel, concave grooves in the stone.
- Thermal/Flamed: Finish is achieved by applying a high temperature flame and cool water to the surface of stone simultaneously. The flame fractures the crystals on the face, while the water prevents splitting, leaving a rough textured finish. The thermal finish is commonly used on exterior paving applications. Since it is highly slip resistant.
- Sand Blasted: (Fine/coarse/stippled): Powered by compressed air, the sand blasted machine forces 20, 40 and 60 grade sand directly on to the stone. This leaves a fine to coarse planed surface on the stone.
- Polished Granite: It is highly reflective, and all the colour, depth and crystal structure is brought about by polishing granite, the surface pores become sealed making the stone nearly impervious to weather and chemical wear.
- Standard thickness: for Marble Stone or Granite Stone Slab thickness shall be 18-20 mm, never less than 18mm.

5B.1.10 Finish of working platforms in kitchen/pantry

- Granite Pantry Counters on Cudappah backing: 18-20 mm thick, Pre-polished granite slab top of approved shade laid on 25 mm thick one side polished Cudappah verticals.
- Granite Pantry Counter shall be finished with Marine Ply:
- 600 mm wide pantry counter with top 18-25 mm, pre-polished granite slab top laid on 19 mm thick marine ply backing, supported on SS legs – 50 mm dia, 3 mm thick as directed. 100 mm: Front Fascia, 150 mm: High band above the counter top of the same shade of granite.
- All exposed surfaces of platform shall be finished with same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges shall be half round bull nosed with mirror polished. Item shall include making necessary cut-outs for taking pipes through counter top.

5B.1.11 Polished kotah stone in risers, treads and skirtings

- Thickness: 20-25 mm, Riser/Tread
- Height of skirting: 100 mm

5B.1.12 Vitrified Tiles

- Vitrified tiles shall be (600 mm x 600 mm x 8/10 mm / 1000 mm x 1000 mm x 10/12 mm thick)

The surface shall be laid for the flooring or dado shall be thoroughly hacked, joints of masonry raked, cleaned of all mortar scales, concrete lumps, loose materials, etc. and washed to remove mud, dirt, etc. from the surface. Unless and until the surface is approved by the PMC the flooring and dado shall not be started. The prepared surface shall be thoroughly drenched with water.

- Tiles should be close jointed, all joints shall be uniform and in perfect straight line.
- Colour of tile to be approved by PMC.
- Skirting: 100 mm high, over 10mm thick cement mortar (1:3 Ratio)
- The tile shall be protected with plastic & POP board/ PVC bubble sheet as specified by the ER/PMC

5B.1.13 DADO:

The prepared surface shall be plastered with cement mortar 1:3 to get a bedding of 12mm thick. The specifications for workmanship shall same as tile flooring.

5B.1.14 Twin granite/marble, stone frames:

- The thickness of paste shall not be less than 6 mm and not more than 12 mm.
- The joints shall be cleaned & properly grouted with a neat paste of colors matching the tile.
- The proportion of mortar bedding shall be 1:3, unless & otherwise prescribed any other proportion and shall be as per IS 2116-1965.

5B.1.15 Heat resistant terrace tiles:

- Bed Mortar in ratio 1:4 (Cement to Sand), 20mm and not less than 18 mm.
- Providing cladding on walls machine cut and machine pre-polished Granite slab 18/20 mm thick of size as per drawings set on backing coat of cement mortar 1:3 not exceeding 19mm thick, including pointing with matching cement paste with pigmented additives to match the shade of the slab.

5B.1.16 Interlocking paver block:

- Precast Concrete Blocks for paving shall be conforming to IS 15658-2006.

5B.1.17 Suspended Non-Metal, Non-Asbestos

(Mineral Fiber Reinforced Tile, Densified Calcium Silicate Tile) False Ceiling System:

The work covered by these specifications shall consist of providing all materials, labour, and installation of the suspended false ceiling and vertical masking system with non-asbestos mineral fiber tiles/ calcium silicate densified tiles of specified texture and finish

using suspended pressed GI frame grid work, interlocking, suspended by adjustable M.S. suspenders with necessary cut outs in the false ceiling for lighting fixtures, trap doors, A.C. grills etc., providing MS lighting troughs etc., erecting to proper line and level in the specified areas, floors and levels as indicated in the drawing and as directed by the Engineer-in-Charge.

- Gypsum Board (Plain or perforated) 12.5mm thick, moisture resistant.
- (Plain or perforated) 12.5mm thick, moisture resistant's specified/approved.
- Acoustic mineral fiber reinforced ceiling tiles with factory applied latex paint surface finish 15/16/19mm thick, fire class-A, RH99, NRC>0.50 with specified surface design and edge profile as specified/approved.
- Calcium silicate ceiling board (Hilux) with low thermal conductivity (0.13w/m.0C), non-combustible with fire propagation index 4,100% humidity resistant,12mm or specified thickness with specified surface design and edge profile (M/s Ramco Industries or equivalent) as specified/approved.

5B.1.18 Kerb Stone (Precast)

- Top width: 12.5cm wide
- Finishing: Berms and road edges shall be restored and all surplus earth including rubbish disposed off. extra shall not be paid for this.
- Measurement: Kerb stone shall be measured in running meters.
- Rates: Rate shall include the cost of all materials and labour involved in all operations.

5B.1.19 Lighting Troughs/ Fixtures:

- Fabricated out of Aluminium sheet.

5B.1.20 Aluminum Troughs:

- Aluminium trough Shall be anodized as per standard practice.
- Sample of lighting troughs as per drawings.
- Shall be fabricated and got approved before fixing in position.
- Aluminium lighting troughs with Aluminium frames shall be fixed in position to correct line and level with MS suspenders.
- Before fixing all the lighting troughs it should get approved from the PMC.

Mode of measurement: Shall be measured along the length of trough in running meters.

5B.1.21 Trap Doors:

- Material: Aluminium frame shall conform to the relevant specification giving in the tender.
- Sample of Trap Door of single double and multi panels shall be fabricated and fixed in position.

- All the expose surfaces of MS work including the suspenders shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer.

Mode of Measurement: Measured in square meters for payment.

The rate includes all the accessories required for the false ceiling.

Work to include cost of all labour, false ceiling sheets with anodized aluminum pressed steel frame work, wastages, suspenders, cleats, nuts, bolts, washers, screws, and other fixing material to be painted with two coats of synthetic enamel paint on MS work as directed.

5B.1.22 Mineral fibre / calcium silicate board/ G.I. Sheet covering:

Covering to insulation media shall be as specified in item.

Fire resisting paint: Shall confirm to I.S. 163.

5B.1.23 Cement plastering for walls and ceilings and sand face/ rough cast plasters.

The work covered under this specification consists of supplying all materials and plastering, pointing, finishing strictly in accordance with specifications and applicable drawings.

5B.1.24 Grooves:

The grooves shall be of required dimensions. The finish inside shall be that of the plaster. The grooves shall be well defined and rounded. Shall be paid for extra in the rates given in schedule of quantities.

5B.1.25 Plastering

Shall be thickness of 6/12/15/20.

5B.1.26 Wall care putty:

Consists of white cement, high quality polymers and specialty chemicals and mineral fillers and can be applied on damp surfaces. It is a water-resistant base coating to the plastered surfaces.

5B.1.27 Painting:

These specifications cover the use of paint for plastered and concrete surfaces/ exterior/interior surfaces. It also includes the painting of wood and metal surfaces.

Acrylic emulsion paints are not suitable for application on external wood and iron surfaces and surfaces which are liable to heavy condensation and are to be used generally on masonry or plastered surfaces. Suitable primer as per manufacturer shall be used.

General & Codes

The provisions of the latest revisions of the following IS: Codes shall form a part of this specification.

IS: 63	Whiting for Painting Ready mixed paint, brushing, grey filler, for Enamels, for use over primers.
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IS: 426	Specification for paste filler for colour coats.
IS : 428	Specification for Distemper, Oil Emulsion, colour as required.
IS : 710	Marine Plywood
IS : 1200 (Part XIII)	Method of Measurement of Building & Civil Engg. Works - White Washing colour washing, distempering & other finishes.
IS : 1477 (Part I)	Code of practice for painting for ferrous metals in buildings Pretreatment.
IS : 1477 (Part II)	Code of practice for finishing of ferrous metals in building. Painting
IS : 2338 (Part I)	Code of practice for finishing of wood and wood based materials Operations and workmanship for finishing.
IS : 2338 (Part II)	Code of practice for finishing of wood and wood based materials, Schedule.
IS : 2395 (Part I)	Code of practice for painting concrete masonry and plaster surfaces. Operation & workmanship
IS : 2395 (Part II)	Code of practice for painting concrete, masonry and plaster surfaces. Schedule.
IS : 159	Specification for ready mixed paint, brushing, acid resistant.
IS : 2524 (Part I)	Code of practice for painting of non-ferrous metal in building Pre-treatment.
IS : 2524 (Part III)	Code of practice for painting of non-ferrous metal in building Painting.
IS : 3140	Code of practice for painting asbestos cement buildings.
IS : 5410	Specification for cement paints, colour as required.IS:15489-04 Specification for External Paint

Other IS Codes not specifically mentioned here but pertaining to painting form part of these specifications.

5B.1.28 Types of Waterproofing

(Refer Tabulated Specifications For Each Mentioned Below)

- a) Terrace Insulation and Waterproofing: The system shall be a green and sustainable solutions for the rough with high energy savings and combination of water proofing and thermal insulation with a guarantee of 25 years.
- b) Terrace Garden/ Landscape Area Waterproofing

Technical Details

Physical Properties (liquid Form)		Test results
Color	-	Brown to black
Volatile Organic Compounds	-	Contains no solvents (no VOCs)
Properties (Tested on 1.5mm cured film)	Test method	Typical Value
Tensile Strength of film N/mm ²	ASTM D 412	≥ 1.00
Tear Resistance N	ASTM D 1004	≥ 5
Puncture Resistance	ASTM E 154	Pass [UTM ultimate limit reached]
Elongation %	ASTM D412	≥ 1000%
Water vapor transmission	ASTM E96	0.2gr/h/m ²
Water Permeability	BS EN 12390-8	Nil
Accelerated weathering (1,000 hrs. 7 yrs.)	ASTM G155	Excellent
Impact resistance	ASTM D3746	Pass
Xenon exposure 1,000 hrs. (UV)	ASTM G155	Excellent
Peel adhesion to primed concrete N	ASTM C 794	≥ 25
Low temperature bend	ASTM D2136	Passes at -30deg F
Resistance to puncture	ASTM E154	Pass

c) Washroom/ Bathroom/ Toilet Waterproofing:

5B.1.29 Miscellaneous Works:

- Railing :All Stainless Steel to conform to SS 304 Grade
- SS Railing with Balusters

Staircase Railing 1050mm high with main 38mm dia SS pipe as main runner and 25mm dia pipe at 5 levels along the running length of the staircase and vertical supports in 6mm thick and 38mm wide twin SS plates @ 1500mm c/c, with necessary supports, anchor fasteners, supports, base plates, SS counter sunk screws. The joinery should be assembled at site by Alenkey.

- MS Railing with Balusters

Staircase Railing 1050mm high with 38 mm dia. MS pipes as main runner and 25 mm dia pipe at 5 levels along the running length of the staircase and vertical supports in 6mm thick and 38mm wide twin MS plates @ 1500mm c/c, with necessary supports, anchor fasteners, supports. The handrail to be finished with approved Enamel paint from inclusive of all surface preparation as specific etc complete.

- SS Grab Rail Along Walls

SS Hand Rail along walls with main bar 38mm dia and 1.5mm thick with all necessary fitting as the main runner joined to 6mm thick 25mm wide twin SS plates and vertical bracket 2mm thick held on to walls by means of fasteners base plates to be @ every 1500mm c/c etc. complete.

- **MS Grab Rail Along Walls**

Providing, fabricating and fixing in position MS Hand Rail along walls with main bar 38mm dia and 1.5mm thick with all necessary fitting as the main runner joined to 6mm thick 25mm wide twin MS plates and vertical bracket 2mm thick held on to walls by means of fasteners base plates to be @ every 1000mm c/c etc. complete etc. complete. The handrail to be finished with approved Enamel paint from.

- **Single/ Double Leaf Glass Door Shutter**

Providing and fixing single/double glazed door of 12m thick toughened glass. The door shall be pivot fittings door system using BTS 75 V floor spring set., complete each shutter to have brush stainless steel handle, locks, patch fittings & other fixtures as indicated. The glass shutter shall be provided with 600mm high Handle.

- **M.S. Gates**

Supplying and fixing Electrical operated sliding gates of specified size and width in single / two leaves MS frames as per design including all accessories and bottom angle, roller tracks with heavy duty roller at bottom of gates. Cost to be inclusive of buffing, painting 3 coats with approved shade synthetic enamel paint over a coat of Zinc chromate primer etc. complete and all as directed. Item shall include fixing in position, alignment, grouting the MS support for sliding panels using cement concrete 1:2:4 and finishing the surface neat and smooth etc. Consider weight for sliding gates as 110 Kgs per sqm.

5B.1.30 Structural Glazing

5B.1.30.1 Introduction

Due to its smooth mirror like exterior finish, Structural Glazing nowadays, has become widely used modern material for external walling in high rise commercial as well as residential buildings; it reflects a large portion of the solar radiation falling on the building thereby reducing the heat load inside the building. This leads to better temperature control inside the building even during hot weather.

5B.1.30.2 Specification for Materials

Aluminium extruded sections shall be from approved and reputed / renowned manufacturer. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works.

Structural Sealant: Silicone structural glazing utilizes a high performance silicone sealant to attach glass, metal or other panel material to a metal frame in lieu of gaskets and mechanical attachments. The wind load stresses on the façade are transferred

through the structural silicone sealant to the structure of the building. The structural silicone sealant must maintain its adhesive and cohesive properties in order to support the panels under wind load. Only silicone sealant is suitable for use in structural glazing application.

Substrate for structural glazing shall be selected considering the joint design and adhesive of the structural silicone. A flat surface with no gasket races, key slots, serrations, or other irregularities is required. For extruded substrates the width of extrusion must be adequate to achieve the calculated minimum structural bite with a suitable spacer attached. Extruded mill finish aluminium is not an appropriate surface for structural silicon application due to poor adhesion. The sections should be either Anodized or polyester powder coated as per specification.

In addition to suitability of substrate for adhesion, gasket and other accessory material like cleaning liquid, spacer tape, masking tape, weather sealant etc. must be compatible with the structural sealant. For extruded substrates the width of extrusion must be adequate to achieve calculated structural bite (minimum width or contact surface of the silicone sealant on both the panel and the frame) with a suitable spacer attached

5B.1.31 Furniture

5B.1.31.1 Reception desk:

- ***Supplying and installing Reception Desk:***



Providing and supplying Reception desk in modern design 2400 (L)X 900 (W) x 900 (H) with table top thickness of 36mm in pre laminate particle board. Modesty and side panels shall be made up of 18mm thk pre laminate particle board. Pedestal in 18mm thk. particle board shall be provided with sufficient no. of drawers. Key board and pedestals to have proper lock and key arrangement.

5B.1.31.2 Sofa seating:

- ***Supplying and installing 3 Seater Sofa :***



Foam- The seat is made of PU foam with density 32 ± 2 kg/cu/mtr having an additional top layer of PU foam with density 28 ± 2 kg/cu. Seat is upholstered with fabric or leatherette. Back foam- The back to be made of PU foam with density 28 ± 2 kg /cu. Mtr with two additional top layer of super soft foam of density 23 ± 2 kg/cu upholstered with fabric or leatherette. Under structure- Under structure is made up of 1.2 ± 0.1 cm thick hot pressed plywood measured as per QA method describes in OCP-QLTA-PL14-18.4. Dia.4 mm zigzag spring assembly is mounted in under structure for support and additional cushioning purpose. Leg Assembly- It is a welded assembly made in stainless steel (grade SS 202) tube and plate.

- ***Supplying and installing 3 Seater Sofa at Reception / waiting areas:***



Seat Foam- The seat is made of PU foam with density 32 ± 2 kg/cu/mtr having an additional top layer of PU foam with density 28 ± 2 kg/cu. Seat is upholstered with fabric or leatherette. Back foam- The back to be made of PU foam with density 28 ± 2 kg /cu. Mtr with two additional top layer of super soft foam of density 23 ± 2 kg/cu upholstered with fabric or leatherette. Under structure- Under structure is made up of 1.2 ± 0.1 cm thick hot pressed plywood measured as per QA method describes in OCP-QLTA-PL14-18.4. Dia.4 mm zigzag spring assembly is mounted in under structure for support and additional cushioning purpose. Under structure- Under structure is made up of 1.2 ± 0.1 cm thick hot pressed plywood measured as per QA method describes in OCP-QLTA-PL14-18.4. Dia.4 mm zigzag spring assembly is mounted in under structure for support and additional cushioning purpose. S.S Tubular welded frame from $2.22 \pm 0.03 \times 0.12 \pm 0.0128$ cm and $3.5 \pm 0.3 \times 1.5 \pm 0.3 \times 0.12 \pm 0.0128$ cm stainless steel 202 grade tube. The tubes to be buff polished to give shiny finish.

5B.1.31.3 Other tables:

- ***Supplying and installing for tables for reading purpose***



Worktop of 25 mm thk. PLB tops with 2 mm thk. PVC edge beading. Under structure of 1.6 mm thk C frame supporting the top, and legs of dia. 38.1 x 1.6 mm thk. MS ERW tube.

- ***Supplying and installing for Side table:***



Under structure to be a welded assembly made in SS 202 grade having dia 12+-0.04 as per IS : 1762. Glass- It is 12+-0.3mm thick black tinted Toughened glass UV glued with bushes made in SS 202 grade for fixing with under structure.

- ***Supplying and installing for Centre table***



Under structure to be a welded assembly made in SS 202 grade having dia 12+-0.04 as per IS: 1762. Glass- It is 12+-0.3mm thick black tinted Toughened glass UV glued with bushes made in SS 202 grade for fixing with under structure.

5B.1.31.4 Workstations and Tables

Supply and installation of workstation in office areas with combination of Left hand and right hand side. Workstation of make.



Top- Work surface - 18mm thk. Prelaminated particle board. All work surface edges to be duly sealed with 2mm thk. PVC edge banding. Modesty panel- 18mm thk. Pre laminated particle board. All work surface edges to be duly sealed with 2 mm thk PVC edge banding. (Optional). Rectangular frame- Fabricated component in 1.2 mm thk.

CRCA "D" Grade as per IS: 513. Finish: Epoxy polyester powder coated thickness of 50 micron.(+10 micron). Leg: Fabricated component in 38 X 25 X 1.2 mm thk. MS ERW Tube (IS:7138). Finish- Epoxy polyester powder coated to thickness of 50 micron (+50mm). CPU Modesty-0.8 mm thk."D" Grade as per IS: 513. Finish: Epoxy polyester powder coated to thickness of 50micron (+10mm). Levellers glide for Leg- Nylon 6 & MS Bolt. Horizontal wire carrier- 0.7 MM THK. CRCA "D"grade as per IS:513. Finish: Epoxy polyester powder coated to thickness of 50mm (+10mm). Vertical wire carrier- 0.8 mm thk. CRCA "D"grade as per IS: 513. Finish: Epoxy polyester powder coated to thickness of 50mm (+10mm). Pedestal- Drawer configuration/product size/ styling: Box-Box- File 355.5 x 559 x 870, Enclosing, Including leveller. Construction and material- Welded assembled.Shell-0.6 mm thk. CRCA as per IS-513. Drawer tray & back - 0.5 mm thk. CRCA as per IS-513. Drawer front- 0.6mm thk CRCA as per IS-513. Locking- Cam lock, Leveller- Plastic M8 leveller mounted below body shell. Handle- Injection moulded polypropylene, Finish- Epoxy polyester powder coated to the thickness of 50 microns (+_10).

Top: 25 mm thk. Particle board clad with 0.6 mm thk. Post formed laminate and 1 mm thk. Backing laminate. Flat edge duly sealed with 2 mm thk. PVC beading. Modesty- 18 mm thk. Plain particle board clad with 1.0 mm thick decorative laminate on both sides. Edge sealed with 2 mm thk. PVC beading, Extended Return Unit (ERU). Top: 25 mm thk. Particle board clad with 0.6 mm thk. Post formed laminate and 1 mm thk. Backing laminate. Flat edge duly sealed with 2 mm thk. PVC beading. Modesty- 18 mm thk. Plain particle board clad with 1.0 mm thick decorative laminate on both sides. Edge sealed with 2 mm thk. PVC beading, Hinge door unit. Top & Side Panel-25 mm thk. Particle board clad with 0.6 mm thk. Post formed laminate and 1 mm thk. Backing laminate. Flat edge duly sealed with 2 mm thk. PVC beading. Doors, Partitions and Shelves- 18 mm thk. Plain particle board clad with 1.0 mm thick decorative laminate on both sides. Edge sealed with 2 mm thk. PVC beading,

- ***Supply and installation of workstation in MD's cabin - Godrej Cignus or equivalent.***



- ❖ **Main Table- Work surface - Made of 25 mm thk. Pre laminated twin board and approved shade conforming to IS - 12823:1990, Edge banded with matching 2 mm thk. PVC lapping. Secondary work surface made up of 25 mm thk. MDF on one side pre-laminate board confirming to IS-14587:1998 WITH 0.4 mm PVC membrane**

pressed on top. Soft closing access flap within build power box to be provided on work surface for wire management. Modesty panel to be 25mm thk. MDF - one side of which to be laminate board confirming to IS-14587:1998 with 0.4mm PVC membrane pressed on top. Under structure made of 25 mm thk pre laminated twin board and approved shade conforming IS - 12823:1990, Edge banded with matching 2 mm thk. PVC lapping. Integrated pedestal of 25 mm thk. Pre laminated twin board of E1-P2 grade and approved shade conforming to IS-12823:1990, edge banding with 2 mm thick PVC lapping. Drawer fronts made of 25mm thk. MDF - one side per laminated board confirming to IS 14587:1998 with 0.4 mm PVC membrane pressed on to top. Drawers to have soft closing and anti-slam mechanism. Pedestal to be provided with lock for security. Handles to be provided for ease of operation. Main table with ERU with pedestal 2350W X 1150 D X 750 H., Back unit. Top panel made of 25mm thk MDF - one side pre laminate board confirming to IS-14587:1998 with 0.4 mm PVC membrane pressed to top. Slide door unit made of 25mm thk. Pre laminated twin board and of approved shade confirming to IS-12823:1990, edge banded with matching 2 mm thick PVC lapping for body panels like side, bottom, back and shelves. Shutters are to be made up of 25mm thk. MDF- one side pre laminate board confirming to IS-14587:1998 with 0.4mm PVC membrane pressed on to top. Shutters have a soft closing and anti slam mechanism. Handles are provided for ease of opening. Storage to be provided with lock for security.

- ***Supply and installation of workstation in Service area other than office. Workstation of make Godrej Unitized tables or equivalent.***



Top- Work surfaces- The panels are made from 18+0.5 mm thk. Pre laminated boards as per with 2 mm thk. PVC edge banding on all sides. * T-104- 25+_0.5 mm thk . Pre laminated board. Under structure C-Frame - Made from 0.9+_0.09mm thk. Powder coated 50 microns (+_10) CRCA MS. Tubular frame- For T8 & t9 - Dia 25.4+_0.3mm X 1.2+_0.096mm thk. MS ERW. For others- Dia 25.4+_0.3mm X 1.2+_0.096mm thk. MS ERW tube. Modesty panel- Made from 1.0 +_0.09mm thk. Powder coated 50 microns (+_10) CRCA MS. Storage, Shell- 0.6 mm thk. CRCA as per IS – 513, Drawer tray & back- 0.5 mm thk. CRCA as per IS – 513, Drawer front- 0.6 mm thk. CRCA as per IS – 513, Lock- Cam lock, Handles- Plastic handle.

- ***Supplying and installing discussion Meeting/Conference Room tables in sizes and shapes as per the details given below:***



Work surface (Veneer)- Top thickness 31mm thk+ \pm 1.5mm(18mm +12mmMDF as per IS 12406 + Natural veneer on top surface and balancing laminate on bottom surface) . Chamfer edges and veneer portion of worksurface in finished in PU Matt paint. Work surface (Membrane)- Top thickness 30 mm + \pm 1.5 mm (18mm +12mmMDF as per IS 12406 +0.4 mm membrane foil and balancing laminate on bottom surface. Work surface (Laminate)- Top thickness 31 mm + \pm 1.5 mm (18mm +12mmMDF as per IS 12406 +0.6 mm post laminate on top surface and balancing laminate on bottom surface) and PVC banding on straight top side edge and specially designed T Beading fixed side edge for sleek look. Under structure, Legs- Made from 1.6 mm matt silver anodized aluminium extrusion. Leg assembled together with a plastic holder at bottom and 5 mm HR Steel (IS:2062) which is powder coated (DFT 40-60 microns). The plastic glide holder is having provision for wire entry and glide fixing. The wire carrying is facilitated through the hollow space between two led extrusions and the wired are concealed between removable rigid PVC extrusions in the leg. Veil & cross members- Made from 18 mm thk. PLT+ \pm 1mm as per IS- 12823 and PVC edge banding on all the sides. Access flap and switch mounting tray- Made from matt silver anodized aluminium extrusion and plastic moulded components to facilitate access of Electrical/ Data / Voice sockets access from top. Powder coated (DFT 40-60 microns) switch mounting tray made from 0.8/1.2 mm CR steel IS- 513. Switches to be mounted on tray as per requirement. Provision for mounting 8 module switch plate on switch mounting tray.

- ***Supplying and installing discussion / Conference Room tables in sizes and shapes as per the details given below:***



Work surface (Membrane) Top thickness 25 mm thk. + \pm 1.5mm (25mm +12mmMDF+0.4mm membrane foil). Work surface (Laminate) Top thickness 25 mm

thk. ± 1.5 mm (25mm MDF OSR As per IS 12406 ± 0.6 mm post laminate on top surface and balancing laminate on bottom surface) with PVC edge banding . The work surface has rounded corners. Legs- Nickel chrome plated squeeze leg made from dia. 50.8 x 1.6 mm thk. MS ERW tube. Leg assembled together with a plastic glide at bottom and powder coated leg connector made from Aluminium (Pressure die cast) alloy at top. Laminated modesty- Made from 18mm thk. PLT ± 1 mm as per IS- 12823 OR 16 mm plain particle board ± 0.6 mm top laminate on either side and PVC edge banding on all the sides. Work surface and modesty are assembled together with powder coated (DFT 40-60 microns). Modesty bracket made from 2m thk. CR Steel IS:513. Access flap and switch mounting tray- Made from matt silver anodized aluminium extrusion and plastic moulded components to facilitate access of Electrical/ Data / Voice sockets access from top. Powder coated (DFT 40-60 microns) switch mounting tray made from 0.8/1.2 mm CR steel IS: 513. Switches to be mounted on tray as per requirement. Provision for mounting 8 module anchor roma switch plate on switch mounting tray. Flexible wire carrier- Fixed to work surface from bottom side for holding wires. The wire carrying is facilitated through the hollow space between plastic components.

5B.1.31.5 Cafeteria tables:

- *supplying and installing of cafeteria tables:*



Option 01: Work surface of base material 25mm MDF Board, PVC Membrane on top 8 X 2 mm deep groove on centre of the table as graphics. Edge to be specially profiled to prevent stripping of foil and comfortable touch. Option -02: PU Painted - Base material - 25mm MDF Board, On top PU painting of minimum 2H hardness with 75 % glass as per colour chart. Specially profiled edge for comfort. Bend pipe under structure of MS Powder coated. Pipe dia 38mm, 2 mm thk. Under structure fitted with top by SS machine screws. Legs: MS Powder coated legs for PU top and SS Legs for membrane top 38mm dia. Pipe legs are fixed with under structure and table top. Glide; Plastic glide fixed at the under structure to prevent the damage of table top during stacking.

5B.1.31.6 Seating chairs:

- *Supplying and installing of high back seating in GM Cabin*



Seat Assembly to be cushioned made of injection moulded plastic outer and inner. Inner plastic to be upholstered with pure leather and moulded high resistance (HR) Polyurethane foam of density $45.2 \pm 2 \text{ kg/m}^3$ and hardness load of $16 \pm 2 \text{ kgf}$ as per 7888 for 25% compression. Back assembly to be cushioned back made of PU foam with in situ moulded MS ERW. Round tube of size $1.9 \pm 0.03 \text{ cm} \times 0.16 \pm 0.0128 \text{ cm}$ and upholstered with pure leather. Armrests- To be moulded from PU upholstered with pure leather and moulded on to a drop lift adequate type tubular armrest support. Adjustable tilting mechanism with active bio synchro mechanism. Seat depth adjustment to be integrated in the seat through a sliding mechanism. Back support with up/dn mechanism housed in plastic T Spine. Pneumatic ht. Adjustment. Pedestal assembly of high pressure die cast polished Aluminium and filled with twin wheel castors. Twin wheel castors to be injection moulded in plastic.

- ***Supplying and installing Seating in Cabin Areas -***



The seat back assembly- The cushioned seat assembly to consist of seat outer (material -30% glass fibre nylon) and upholstered seat inner in polypropylene with moulded polyurethane foam and polyester fabric and upholstered using Polyester mesh fabric with high tenacity yarn. The HR polyurethane foam is moulded with density $45 \pm 2 \text{ kg/m}^3$ and hardness load $12 \pm 2 \text{ kgf}$ as per 1S; 7888 for 25% compression. The back support spine to be made up of High pressure die cast polished aluminium. Armrests to have 2 adjustments. Height ($6.0 \pm 0.5 \text{ cm}$) and depth ($6.0 \pm 0.5 \text{ cm}$). Height adjustment is provided in Al. Structure of armrest which is connected to Al. Back spine and is operated by button. The depth adjustment is provided in pad which is fixed to armrest structure. Armrest top is made of PU moulded over plastic inner. Active Bio synchro mechanism- The adjustable tilting mechanism is designed with the following features: 360 degree revolving type. Front pivot for tilt with feet resting on ground and continuous lumbar support ensuring more comfort. Tilt tension adjustment can be

operated in seating position. 5 position tilt limiter giving option of variable tilt angle to the chair. Seat/ back tilting ratio of 1:2. The mechanism housing is made up of HPDC Aluminium and black powder coated (DFT 40 to 60 micron). Seat depth adjustment is integrated in the seat through a sliding mechanism. Seat depth adjustment range is of 3.75 ± 0.1 cm. The lumbar support assembly consists of lumbar spine (material - glass fiber filled nylon) which is fixed to Al. Back spine. Lumbar pad is fixed to lumbar spine through lumbar pad support. Lumbar support assembly has height adjustment of 5.0 ± 0.5 CM. The neck rest assembly consists of upholstered neckrest inner with moulded polyurethane foam and polyester fabric. Upholstered inner is fixed to neck rest cover. Neck rest is to be fixed to back assembly through neck rest spine. Neck rest assembly has height adjustments of 5.5 ± 0.5 cm and rotation adjustment of overall 20 ± 2 . The pneumatic height adjustment has an adjustment stroke of 10.0 ± 0.3 cm. The pedestal assembly to be high pressure die cast polished aluminium and fitted with 5 no. Twin wheel castors. The pedestal Twin wheel castors to be injection moulded in black PP having 6.0 ± 0.1 mm wheel diameter. also 65 ± 0.5 cm pitch centre dia.

- ***Supplying and installing Seating in Office Areas***



Seat / Back Assembly: The seat and back to be made up of 1.2 ± 0.1 cm thk. Hot pressed plywood measured as per QA method described in OCP- QLTA-P14-18 and upholstered with fabric upholstery covers and moulded polyurethane foam. The back foam is designed with contoured lumbar support for extra comfort. HR Polyurethane foam to be moulded with density 45 ± 2 kg/m³ and hardness load of 16 ± 2 kgf as per IS 7888 for 25% compression. Armrests to be one piece in injection moulded from black co-polymer polypropylene. The seating to have central tilt synchro mechanism. The pneumatic height adjustment of adjustment stroke of 12 ± 0.3 cm. Telescopic bellow assembly in 3 piece telescopic type and injection moulded in black polypropylene. Pedestal assembly to be injection moulded in black 33% glass filled nylon-66 and fitted with 5 nos. Twin wheel castors. The pedestal to be 66.3 ± 0.5 cm. Twin wheel castor to be injection moulded in black nylon.

- ***Supplying and installing Seating in Conference Rooms***



57.5 (W) x 58.2cm (D) x100.8 cm (H) x47.0cm (Seat Height). Under structure to be MS Powder Coated U/S with Fixed Arm Rest. The seat to have wider upper back and contoured seat in trapezoidal shaped back with lever-less, drop lift function for intuitive height adjustment.

- ***Supplying and installing Chairs for cafeteria***



The seat and back to be made of injection moulded high impact strength polypropylene polymer compound with indoor grade UV resistance. Seat size- 52.5 x 53.2 cm, Back seat 51.6 X 40.5 cm. S.S Tubular welded frame from $2.22 \pm 0.03 \times 0.12 \pm 0.0128$ cm and $3.5 \pm 0.3 \times 1.5 \pm 0.3 \times 0.12 \pm 0.0128$ cm stainless steel 202 grade tube. The tubes to be buff polished to give shiny finish.



Seat assembly- The seat assembly to be made of polyurethane foam moulded with M.S. Tubular frame insert upholstered with fabric. The insert to be tubular frame made of 1.9 dia. ± 0.02 cm X 0.16 ± 0.13 cm thk. MS E.R.W. Round tube with flexible support straps running across the length and width of the frame. The seat to have an anti tip up feature making it stays in upright position when not in use to enable clearing of the row passage. Backrest - The back assembly of PU foam moulded with M.S.Tubular frame insert upholstered with fabric. The chair to rest on ground on two side panel frames fabricated from 0.12 ± 0.020 cm thk. CR Steel sheet, clad with fabric upholstery. The side panel frame to be grouted to the floor using anchors. The synchro slide mechanism with heavy duty slides aiding in relaxed posture. Slider to be connected to

back using linkages to achieve synchronous motion between seat and back. Armrest to be made of integral skin PU foam with hardness and reinforced with wooden insert. The armrest is snap fitted with side panel. All steel component to be epoxy polyester powder coated. (DFT 40-60 microns).



The seat and back to be made up of 1.2 ± 0.1 cm thk . Hot pressed plywood and upholstered with fabric or synthetic leather and moulded polyurethane foam. The back foam is designed with contoured lumbar support for extra comfort. HR Polyurethane foam moulded with density = 45 ± 2 kg.m³ and hardness load 16 ± 2 kf as per IS 7888 for 25% compression. Under structure assembly of welded under structure made of 3.5 ± 0.03 cm X 1.5 ± 0.02 cm X 0.16 ± 0.0128 cm thk MS ERW oblong tube and black powder coated of 40-60 microns.

5B.1.31.7 Storages:

- *Supplying and installing Metal Storages:*



Metal door partitions at centre with half shelves on each side. Construction and Metal-Rigid knock down construction. Back, side and door are made from 0.7 mm (± 0.07 mm) high yield strength CRCA**, rest in 0.8mm (± 0.08 mm) CRCA** as per IS- 513. Sliding / openable door arrangement. Aesthetically appealing door handle to be provided. Screw type leveler with plastic base and finish with epoxy polyester powder coated to the thickness of 50 microns (± 10).

- *Supplying and installing 4 Door Book Rack:*



Top, back and side panel to be 0.7mm high yield strength CRCA, rest in 0.8mm CRCA. With cam lock. Door to have 3 mm thk. Transparent glass for clear inside vision secured in metal frame. Book case to be epoxy polyester powder coated to thickness of 50 microns (+/- 10).

- ***Supplying and installing Optimizer – Welded Storage System***



Optimizers made of CRCA Steel conforming to IS: 513. The sheet thickness for back and shelves to be 0.8 mm while for top and sides to be 0.9 mm. Under carriage to be a welded frame made of HR Sheet 3.15 mm thk. Conforming to IS: 10748 suitably fabricated to take loads based on configuration. The under carriage after pre-treatment is coated with final finish of epoxy polyester powder coat of approved color with a dry film thickness of 40 microns. Optimizer to be equipped with centralized locking, Door locking/ handle, fasteners, guide channels etc.

- ***Supplying and installing Storage Units in Laminate Finish***

Providing and constructing low/ full height storage of width 450mm / 600 mm and size as per drawings, with top, sides and bottom in 19mm thick OSL MDF, back in 8mm thick DSL MDF, intermediates in 19mm thick DSL MDF, shutters in 19mm thick Exterior grade MDF with post formed edges. All external surfaces to be finished in approved laminate, with balancing laminate on the interior surface. All exposed edges for intermediates to be in PVC edge binding. Drawers to be provided as indicated in drgs. Rate to include hardware such as approved telescopic sliding channels, approved locks, auto closing hinges for shutters, approved handles, door stop,

- ***Supplying Overhead Storage***



Providing and constructing overhead storage of depth 300mm, height 600 mm and Length as per drawings, with top, sides and bottom in 19mm thick marine grade plywood, back in 8mm thick marine ply, intermediate in 19mm thick marine grade plywood, shutter in 19mm thick MDF with post formed edges. All external surfaces to be finished in approved laminate, with balancing laminate on the interior surface. All exposed edges to be finished in approved PVC edge binding. Rate to include hardware such as approved locks, auto closing hinges for shutters, approved handles, door stop, tower bolt, etc. complete. (Shutter width not to exceed 450mm).

- ***Supplying and Supplying Below Counter Storage***



Providing and constructing shutters below pantry/kitchen/ any other counter made of 19mm thick Marine ply finished in approved shade laminate on exposed surface and balancing laminate on internal surfaces inclusive of necessary teak wood beading and frame work finished in matching colour polish matching the shade of the laminate or as directed, Cost to be inclusive of horizontal shelves in 19mm thick marine ply finished in approved laminate and vertical supports in 19mm marine ply @ 600mm c/c. (as required). Cost also to include SS trolleys in 304 grade, as indicated in drg. Cost to include providing SS baskets in 304 grade for garbage, fixed on shutter inside at Sink area. Hardware to include approved Telescopic sliding channels, dead locks with SS finished keyhole, brush SS finish handle, SS tower bolt, magnetic ball catches etc. complete. Storage below counters - 3000mm length X 750-800 mm height X 600 mm depth. Consider one trolley for one division of minimum 900mm width.

5B.1.31.8 Soft Board and White Board:

- ***Supplying and Supplying Soft Board:***

Providing and fixing Fabric wrapped soft board panels 12mm thick of size and profile as per detail with 6mm grooves made at the junction of soft board and partition and finished with Aluminium Hat sections. Soft board to be fixed on a backing of 12mm exterior grade MDF with PVC grippers at the edges. The rate should include cladding the panels in approved fabric (basic price Rs. 300/Rmt), 4mm thick foam infill as per approved specification. Note the fabric shall be stretched uniformly along the direction of weave and shall be wrinkle free.

- ***Supplying White Board:***

Providing and fixing 1mm thick White writing laminate on 12mm thick exterior grade MDF with grooves at the junction of writing laminate and partition as shown in the drawings. Cost to be inclusive of Aluminium beading at all edges of the MDF on which the laminate is stuck. The cost to include supplying and installing approved pen & duster holder with necessary supports, hardware, etc. complete.

5B.1.31.9 Lockers



Providing and fixing Lockers of size 900 long x 300 deep x 1950mm (each locker 300 X 300 X 300 clear) Each component to be Made from Powder coated 50 microns CRCA MS. Tubular frame, given through 7 step anti rust treatment and approved shade Powder coated, Concealed flush type handle with inbuilt locking facility, Label holders for easy identification, ventilation louvers and provision for indexing and numbering of Godrej or equivalent make. Also provide option for configuration of locker space for hanging clothes.

5B.1.31.10 Blinds:

- ***Supplying and Supplying Roller Blinds for Admin Cabin and Conference Rooms:***

Providing and fixing roller blinds of approved make as per the manufacturer's specifications with drive unit, End plug, support brackets, roller tube, bottom rail, ball chains all described below. Drive unit to be of moulded plastic with straight rectangular support pin and inserted into the tube end. It shall be driven by a ball chain pulley and can be positioned at right or left side of the shade. The shade when lowering or raising shall automatically be lockable upon release of the ball chain by means of friction lock. End plug shall be moulded to plastic locking pin. The plug shall be inserted into the tube end. Support brackets shall be of zinc plated steel and provided with moulded

plastic covers and used in right- or left-hand positions differentiated by acceptance of the rectangular drive unit support or the round idler plug pin. Roller tube shall be made out of roll formed steel of thick. Suitably protected against corrosion, and keyway integral with the tube to accommodate the spline, Outside diameter of the roller tube shall be 25mm. Bottom rail shall be a stiffening element inserted into a bottom rod pocket. Tube to be of the material as approved out of timber, PVC, steel or VB bottom rail. Ball chain shall be 2mm diameter cord with acetyl balls moulded co-axially to it on 6mm pitch to form ball chain. Rate to include the cost of decorative trims also. Consider Basic rate of Fabric as Rs. 400/Rmt.

- ***Supplying Venetian Blind:***



Supplying and Installing, venetian blind consists of approved color & shade, Opaque , with high tear strength constructed out of Antistatic, resilient, color fast & Sanitized Treated 100% spun bonded polyester fiber & precision manufacture to form a hexagonally shaped pleat with cellular construction, Easy Rise Shaft, Easy Rise Lift Set, Spool Assembly, Easy Rise Tape, Easy Rise Clutch Set, Clutch Cover, Clutch End cap, Shaft Retainer, Head Rail End Cap, Cord Loop, Cord Tensioner, Mounting Kit, Easy Rise Headrail, Filler strip, Bottomrail, Bottomrail End Cap, Easy Rise Installation Bracket , Extension Bracket Polyester Code, Slat Insert, Cord lock, Cord Guide, Hold on Bracket, Cord Equalizer etc. All mountings and supporting cords are concealed.

- ***Supplying and Supplying Vertical Blinds: For Admin Office Spaces***



Supplying and Installing, vertical blind consists of:

- **Fabric:** of approved color & shade, Opaque , with high tear strength constructed out of Antistatic, resilient, color fast, fade resistant, twist resistant & Sanitized Treated 100% spun bonded polyester fiber. 0.023" thick
- Head Rail shall be of 1 15/16" in width and 1 3/8" in height, with an average wall thickness of 0.029 inch. Painted off-white finish, weight 0.221 lbs/ft.
- Carrier body for smooth of operation and even spacing of carriers. Molded, impact-resistant plastic, with a detachable stem. Carrier shall traverse on self-lubricated wheels to reduce draw force, and the louver stem shall be replaceable without demounting the headrail. Carriers to be located in the center headrail, making headrail reversible.
- **Gear system:** Rotation and traversing of louvers is accomplished by an aluminum wand attached to the lead carrier. This drives an extruded (.300 dia.) 8-prong aluminum pinion rod passing through all carriers and transmits rotation to each louver stem through a molded rack and pinion gear system. The drive system shall rotate all louvers simultaneously a full 180 degrees and hold them in a fixed position until reset.

5B.1.31.11 Wall Paper

Providing and fixing anti-bacterial / anti-microbial, ISO 22196 (JIS Z2801) rated, durable water resistant, fire retardant, PVC wall paper (Bio Hygienic) of approved shade with recommended adhesive of approved make and sample as per manufacturer's specifications included with preparation on the panned surface for receiving the Poster as per the manufacturer specification.

5B.1.31.12 Pelmet and mirror:

- ***Supplying and Supplying Pelmet:***

Providing and fixing pelmet for projection screen made of 19mm thick MDF of approved make, having clear internal dimensions as 150 x 200mm, finished in approved shade laminate, supported from RCC ceiling slab by necessary framework, giving additional supports in aluminium angles, inclusive of cutting to required sizes etc. complete.

- ***Supplying and Supplying Mirror:***

Providing and fixing Mirror for Toilet of all shapes and sizes as per drawings using 6mm thick mirror of approved make cut to required sizes on a backing of 12mm thick Marine plywood of approved make stuck to wall/partitions. All edges of the mirror to be machine polished. The mirror to be stuck by means of BOW or 3M tapes. The cost to be inclusive of making mirrors in any profile as indicated in the drawings and also include SS Beading all along the edges of the mirror

5B.1.31.13 Panelling and boxing:

- ***Supplying and Supplying Panelling and Boxing:***

The cost of laminate given below is the landed cost of the material, with all taxes, delivery, transport and all taxes thereon. All internal wooden framework to be treated with 1 coat of anti-termite coat/paint of approved make as per manufacturer's specifications. For all panelling at the junction of plaster / putty with panelling, the rate to include 4mm groove. For all Acoustical board and soft boards, fabric to be wrapped by 150mm onto the inner side of the board as shown in the drawings. The cost of extra fabric is to be incorporated in the cost. For all laminate or any other panelling up to false ceiling level, the rate to include 4mm groove at the junction of false ceiling. All laminate joints to be painted with matching colour laminate to the approval of the architect. Rate for all panelling and boxing to include treating all ply and wood and or wood derivatives with anti-termite chemicals. Wherever mentioned, 1mm thick laminates to be Rs. 450/Sqm inclusive of all applicable taxes and delivered at site. The cost to include wooden packing below bottom member fixed on floor and on ceiling or where ever applicable to get the fixing level of the member correct and aligned to other existing finishes. The cost to include T angle at the junction of White board and soft board wherever applicable Mode of measurement to be Length of Boxing or Panelling x height.

5B.1.31.14 Low Height Partition:

- ***Supplying and Supplying Low Height Partition:***

Supplying and installation of 60 mm to 70 mm thick Tile Based Partition System of having inner framework of CRCA steel of 16 gauge of Grade D as per IS:513 covered with tiles on both sides and covered with Aluminium powder coated trims on top and end sides. with steel raceway at bottom level. And the system with option of various kinds of board like 9 mm MDF tiles of exterior grade - I conforming to IS : 14587 fabric board & white marker board. All metallic parts undergo a 7 stage antirust treatment and powder coated in matt finish to a thickness of 40-60 microns, The modular partitions will be independent and not to be grouted in the floors. The modular partitions assembly will be with the following parts a) Frame b) Tiles as specified c) Trims d) Corner Post e) Junction connector f) Groove Covers g) Wire Management and h) Levellers as per particular specification.

5B.1.31.15 Raised Access Flooring (False Flooring)

A raised access floor is used to provide a means of creating a void below floor level which is capable of ensuring building services are available at their required destination. These services will typically include electrical power, data cables, telecom, air-conditioning, fire detection, security, water and drainage etc. as per functional requirements. The use of raised access floor also allow quick and easy access to these services for maintenance reasons.

5B.2 SPECIFICATION FOR LANDSCAPE WORKS:

5B.2.1 Site Dressing and Land Modulation

Scope of work

- The Scope consists of clearance of the Site of Works and preparation of the same to commence the proposed landscape execution activities. Wherever applicable, this is deemed to include all preliminary works like Dismantling/Demolition, Site Clearance, and General Leveling etc.
- The work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Landscape PMC duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Landscape PMCs signature and stamp.
- The work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings etc.

General Items

The more important Codes, Standards and publications applicable to this section are listed hereinafter.

a) Setting out the works

- The Contractor shall supply without additional charges the requisite number of persons with the means and material necessary for the purpose of setting out works and checking, weighing and assisting in the measurement or examination at any time and from time to time, of the work or the materials. Failing this, the same may be provided by the Authority's designated representative In-charge at the expense of the Contractor and the expenses shall be deducted from any money due to the Contractor under the contract or from his security deposit.
- The Contractor shall arrange for a qualified surveyor to set out the works and obtain certification of its accuracy from the surveyor. The Contractor shall then set out the works and shall be responsible for the true and perfect setting out of the same and for the correctness of the positions, levels, dimensions, and alignment of all parts thereof and for provision of all necessary instruments, appliances and labour in connection therewith. The Contractor shall submit to the Authority and the Landscape Architects, margins and the verifications of layout within seven days from the date of getting site layout from Landscape Architects / Authority.
- Mark the layout on the site. All bench marks, levels should be properly established and preserved for future use.
- Clearly check the surveyed map provided by the Authority and mark all drainage lines, water pipe lines, electrical lines, etc. Authority has been asked to remove the electrical

lines and electrical poles. It needs to be checked by Contractor to satisfy him / herself from safety point of view before starting of work.

- The checking of any setting out or of any line or level by the Landscape Architects and AUTHORITY's representative or their representative shall not in any way relieve the Contractor of his responsibilities, for the correctness thereof. The Contractor shall carefully protect and preserve all benchmarks and other things used in setting out of the work.

b) Site Clearing / Excavation / Site Grading

- Light irrigation, by flooding the whole site with water. The water should penetrate up to depth of 15-20 cm only so that the weeds can germinate. Remove all grasses, small shrubs/weeds etc. with roots. Excavating the site as marked on the drawing/as instructed at the site, up to any lead and lift.
- Verify the levels and bench-marks from the up-dated surveyed drawing made available by the Authority. If there are any discrepancies between the site and the survey drawing, the same are to be brought to the Authority's notice by addressing a letter to the Authority and copy marked to the Landscape Architects.
- Grading and levelling of site as shown in drawing / specified on site by Landscape Architects. This will include spreading manually or by help of soil unloaded at different working areas in the site so as to obtain basic datum levels and grades.
- Excavated material shall be stacked off in the manner indicated at the site including stacking of excavated material up to any lead and lift. The rate shall only cover the cost of excavation, stacking and/or spreading of the material, if required at the site.
- Clearing the area of unwanted materials including the weeds, stones, masonry pieces etc. and all such matter that may cause damage to growth of the plant materials immediately or in future.

c) Earth Works

- Earthworks shall involve the grading of soil for earth mounding, the excavation of trenches and soil for formation levels of pathways and foundations, and the fine grading of earth banks and landscape areas roughly graded by others.
- Excavation shall be carried out to the depth shown on or implied in the drawings or to such greater or lesser depths as the Landscape Architect may direct. The Contractor shall supply and fit all shoring, sheeting, strutting and walling required to maintain the sides of excavations as long as necessary and to remove them as required. The Contractor is to allow for making all necessary adjustments to existing manholes in accordance to bring them to the same level as the required profiled grades. No claim

shall be entertained for either bulking or compacting and all other quantities shall be measured net from the drawings.

- The stripping and replacement of the subsoil shall only be done in dry weather and ground conditions unless in exceptional circumstances the Landscape Architect authorizes otherwise. Subsoil in heaps or dumps shall not be sited so as to damage or impede water courses or other drainage so long as they are capable of remaining in operation. Any weeds which may grow on the heaps of subsoil shall be sprayed with an approved selective weed-killer to prevent seeding.
- Notwithstanding the general description for the type of material to be excavated, if original bed rock is encountered during these operations which can only be removed by blasting or compressed air tools this work will be paid for separately as an extra over item for that given for normal excavation. This work shall only be undertaken when authorized in writing by the Landscape Architect.
- During excavation it is expected that the Contractor will take every prudent step or precautions such as tests or borings in order to prove the nature or type of material underneath or the ground bearing capacity in order to protect his workmen, plant or machinery employed in these operations.
- In the event of the Contractor excavating below the proper levels or otherwise in excess of the dimension given, he shall at his own expenses, remove all loose excavated material and replace the soil excavated in error.
- If, in the opinion of the Landscape Architect the bottoms of any excavation or any material to be excavated become unsuitable due to the Contractor's operations, the Contractor shall, at his own expenses, carry out any necessary excavation and make up in a similar manner to the above.
- If, in the opinion of the Landscape Architect the weather conditions are such as to preclude the satisfactory completion of any operation or cause unnecessary nuisance or disturbance to other parties, the Contractor shall, on receiving directions from the Landscape Architect suspend operations on that particular portion of the work until the Landscape Architect considers that weather conditions are satisfactory, or issues a direction to re-commence operations. The absence of such a direction shall in no way constitute the basis of a claim for delay or remedial work to a formation which is unsuitable.

d) Major Grading

- Site shall be complete with rough dressing including the base levels by civil contractor before handed over to landscape contractor for execution.

- Role of Landscape contractor involves major grading forming earth mounds / hillocks from imported fill materials where specified, or from the site debris and soil generated by excavations. The soil shall be graded using suitable earth moving machinery to the contoured earth forms indicated on the drawings. Soil, when in a dry enough state for easy working, shall be distributed to the correct areas and laid in layers not exceeding 100mm thick and compacted by at least 2 passes of the earth moving machine in each direction for each 100mm layer.
- Earth slopes are to be formed from the compacted mounds to the gradients and levels shown on the drawings, accounting for the topsoil depths to be included after subsoil formation is complete. If insufficient fill is available to complete the levels shown, additional suitable subsoil is to be imported to make up the required quantities. Importation of additional fill shall only be carried out with written permission of the Landscape Architect.
- Earthworks levels are to be carried out to the contours shown on the drawings to a maximum tolerance of 150mm measured vertically, and to a maximum gradient of 1:2. All subsoil levels are to account for the later additional of specified depths of topsoil.
- The Contractor shall be responsible for protection of completed subsoil mounds and shall take preventative measures to control erosion and siltation restore or replace any portion of the earthwork areas which erodes, slumps, silts or is otherwise damaged by the out-washing of soil.

e) Excavation for Formation Levels and Trenches

- For footpath areas or other paving areas, excavate subsoil to create a smooth formation for taking the sub-base for the paved area, to levels shown on the drawings accounting for the depth of the paving build up.
- Firmly compact sub-grade with a smooth wheeled vibratory roller to achieve an even level. Finished sub-grade is to be protected until the path sub-base or other construction such as pool sub-base is laid. If sub-grade is too dry to be compacted, water shall be added until suitable texture is achieved. If sub-grade is too wet, the material shall be left to dry out until workable.
- A completed sub-grade/formation on which there is standing water, soft spots or slurry shall be deemed to be unsuitable and shall be rectified at the Contractor's expense including making up of additional material as required to bring the formation to line and level again.
- Where soft or wet ground is encountered prior to preparation of the sub-grade and this soft or wet ground cannot satisfactorily be compacted, the Contractor shall submit a written request for this to be inspected and the area to be dug out and replaced with

suitable material shall be evaluated by the Landscape Architect and directed accordingly.

- Surplus material resulting from excavations for path formation or drainage trenches shall be taken off site at Contractor's own expense unless otherwise directed by the Landscape Architect in writing.
- Excavation of drainage or formation trenches shall be carried out after the major grading has been completed and approved. Trenches shall be cut to lines and gradients shown on the drawings. Planking and strutting shall be carried out as required to make the sides of the trenches safe. The Contractor will be responsible for ensuring that drainage trenches are kept free from mud and water and side slippage.

f) Fine Grading and Shaping

- Slight unevenness, ups and downs and shallow depressions shall be removed by fine dressing the surface to the formation levels of the adjoining land, as directed by Landscape PMC and adding suitable quantities of Good earth, brought from approved source, if necessary.
- Fine grading shall be carried out using small sized earth moving equipment or by hand, and shall involve final modeling of the earth contours produced by the major grading exercise. The shaping will follow the contours shown on the plans in general terms, but the final forms will be developed by eye to create smoothly flowing and pleasing contours.
- The Fine Grading will provide the detailed earth contouring prior to cultivation of soil. Soil cultivation and the application of topsoil mixes shall not take place until the Fine Grading is completed.

5B.2.2 Soils: Materials and Preparation

➤ Soils

Subsoil

- Subsoil shall be a free draining soil, generally from horizon over 300mm below the original surface to be used as fill materials, either excavated from areas of the site, or imported.
- The Contractor shall:
 - a) Furnish the source of top soil to Authority.
 - b) Study the soil report provided with the tender document, providing soil details such as pH, alkalinity, total soluble salts, porosity, sodium content and organic matter.

- c) Use the restored soil at site for landscape purpose, manure mixture, Neem cake, weedicide shall be added if required.
- d) Not consider any external soil source unless the existing soil conserved from site is lacking in quality and/or quantity.

Topsoil Mixes

- The components of the Topsoil Mixes shall be as follows:
- Topsoil shall be a free draining organic soil from horizons less than 300mm from the original surface, of a workable crumbly and lump free loamy character and shall contain no grass or weed growth of any kind or other foreign material or stones exceeding 25mm in diameter. Total stone content shall be no greater than 15% by volume. A 1 litre sample with back up soil test data is required before installation, or mixing.
- TOPSOIL SPECIFICATION: The following criteria shall be tested at an approved laboratory before use on site.
- pH: 5.5 - 7.8
- Electrical conductivity: 1:2.5 (w/v)
- Soil-water extracts not exceeding 1500 micromho/cm (1500 micro-Siemens/ cm)
- Soil texture:
 - e) Sand (0.05 - 2.00mm): Max. 75% Min. 20%
 - f) Silt (0.002 - 0.05mm): Max. 60% Min. 5%
 - g) Clay (less than 0.002mm): Max. 30% Min. 5%
- Soil Conditioner shall be dried treated sludge, organic compost or other fibrous approved organic matter suitable for mixing with topsoil to make a friable growing medium for plants, resistant to rapid decay, free of soluble salts below 900ppm, pH 6-7, free of large lumps or debris.
- Organic Compost shall be organic vegetable compost produced by a thorough horticultural or industrial composting process or Farm Yard Manure (Cow Dung Manure). Compost is to have a clean, un-decomposed smell free from any rotting substances, debris, refuse, clay or visible fungus. A sample is to be submitted for approval before usage. All composts are to be sterilized before being packed for transport and odorous materials used on site will be rejected. Any vermin resulting from use of organic composts will have to be controlled by the Contractor within 12 hours of any infestation.
- Sand shall be a clean, coarse grained and angular material sourced from a river bed with a minimum 1mm diameter section. It shall be well graded, free from soluble salts

ranging in size so that 80-100% passes the 3mm sieve and 0-50% passes the 2mm sieve, with 0% passing through a 1mm sieve.

- Lightweight Aggregate shall be an approved low-density inert material such as expanded shale or clay or volcanic scoria or other porous aggregate capable of being compacted within the soil zone to 90% compaction without being crushed, free from dust and debris, pH 6-6.5, free of soluble salts. A 2 liters sample shall be submitted and tested as part of the soil mix for physical and chemical performance. Materials are to be approved in writing before installation.

Soil Mixes

- The following soil mixes are to be used for different areas and for different types of planting. Minor changes to the proportions shown for particular species may be required, as specified by the Landscape Architect from time to time.
- i. Soil Mix A: for use in natural ground level areas shall comprise the components listed below, which shall be mechanically cultivated to the correct proportions, prior to placement on site or backfilling. Soil Mix A shall comprise the following proportions by volume:
 - Topsoil: 50%
 - Sand: 20%
 - Soil Conditioner: 15%
 - Organic Compost: 15%
 - ii. Soil Mix B: for use in podium area shall be prepared under controlled mixing conditions such as a concrete floor to ensure even mixing. Soil Mix B shall comprise the following proportions by volume:
 - Topsoil: 30-50%
 - Sand: 10-30%
 - Conditioner: 0-20% (as required)
 - Lightweight Aggregate: 0-20% (as required)
 - Organic Compost: 20%
 - iii. Soil Mix C: for use in planter boxes. Soil Mix C shall comprise the following proportions by volume:
 - Topsoil: 40%
 - Sand: 30%
 - Charcoal: 20%

Organic Compost: 20%

Soil Preparation and Application of Soil Mixes

- All subsoil areas to be top soiled shall be cleaned free of rubbish, weeds, all stones exceeding 50mm in diameter and builder's debris shall be removed from site. Any areas which are contaminated by petrol, soil or other toxic substances shall be excavated to 300mm below the contamination and have the excavated material removed from site. The excavated areas shall be back filled with imported topsoil as specified. These operations shall take place immediately before top soiling (with soil mixes) commences.
- Where directed by the Landscape Architect, the ground shall be decompacted by ripping to a depth of 300mm. All obstructions to cultivation or deleterious material brought to the surface shall be removed from the site and any voids left by this operation shall be backfilled with imported subsoil as specified.
- Subsoil shall be formed to the finished levels and contours after settlement and with overall even compaction.
- No topsoil or soil mixes shall be spread, or cultivation carried out until the subsoil operations have been approved by the Landscape Architect.
- Topsoil or soil mixes shall be spread on the designated areas to the depth shown on the drawings. The loose depth of the topsoil shall be sufficient to allow the area to conform to the levels shown on drawings after natural settlement has taken place. Soil Mixes shall not be compressed or rolled to achieve levels. Conversely if levels drop below specified levels, additional soil mixes are to be added to achieve levels.
- Soil Mixes are to be carefully spread by machine or hand in a moist condition. Very wet or dry soil mixes must not be used. Heavy compaction of soil mixes is to be prevented and compacted soil will be rejected. Soil Mixes are to be spread to the following minimum depths in open ground areas:
 - a) Lawn / Turf areas: 300mm
 - b) Shrub areas: 450mm deep
 - c) Tree pits: 1000 x 1000 x 1000mm
 - d) Unless directed otherwise or as shown on the drawings
- The prepared topsoil mix shall be compacted to 80% of maximum density to the depth shown on the drawings in 150mm layers. When planter is filled, water topsoil mix thoroughly to ensure proper and uniform compaction. After 2 weeks, fill with additional topsoil mixture and compact to level and before pavers are laid indicated on drawings.

- When in the opinion of the Landscape Architect site conditions are unsuitable for working, soiling operations shall cease and shall only be resumed when authorized by him.
- Contractor shall be responsible for soil protection and shall take preventative measures to control erosion and siltation of all areas and shall restore or replace any portion of the site which erodes, silts up or is otherwise damaged by out-washing of soil.

Fertilizers

- Chemical fertilizers shall be approved granular slow release compound fertilizers. They shall be stored in waterproof sealed bags under shelter away from water and direct sunlight. Samples of the same to be submitted by contractor before use at site.
- Organic fertilizers shall be organic products such as organic liquid fertilizer, pellets or granules manufactured primarily from organic materials. These products are to be from accredited sources and technical data indicating sources or origin and manufacturing process must be submitted before use. Animal by products must be sterilized before being packed for transport and odorous materials used on site will be rejected. Any vermin resulting from use of organic fertilizers will have to be controlled by the Contractor within 12 hours of any infestation. A sample shall be submitted for review by the Landscape Architect before use on site.

Mulches

- Mulches shall be approved friable composted organic materials. Coco-Peat will not be allowed on its own unless mixed in a proportion of 50-50 with another mulching material free from soluble salts or toxic materials and resistant to rapid decay. Mulches shall have a pH of between 5.5 - 7.0. Samples to be submitted and approved before use.
- Mulches are to be applied in a minimum 50mm layer over the entire surface of shrub and ground cover areas.
- Mulches is to be re-applied to all planting areas every 3 months after initial installation until the end of the maintenance period or until complete surface cover by vegetation is achieved.
- Initial mulching is to take place within 2 days of installation of planting.

5B.2.3 Sub soil Drainage

Subsoil, Field Drains and Trench Drains

- Before beginning installation of drain lines establish invert elevation of city storm drains at points where tree drains will tie in and prepare schematic layout for approval of Landscape Architect before digging trench.

- Surplus material resulting from excavations shall be carted to other fill areas within the site. If no additional fill sites are available, the Contractor shall remove all surplus material from site and deposit it in a Local Authority approved tip.
- The Contractor shall survey the gradient levels of all trench bases to ensure that all falls are continuous from the highest point down to the outlet point at the sump. These findings shall be submitted to the Landscape Architect for verification before any further work is undertaken, either pipe laying or backfilling.
- All trenches when completed and approved shall be lined with approved filter membrane laid over the base of the trench and up the sides with sufficient membrane to wrap over the top of the gravel backfilling with a minimum overlap of 300mm.
- The base of each drainage trench shall have a layer not less than 30mm and not more than 50mm depth of fine stone chippings 8-12mm diameter or coarse sand laid to accurate falls for bedding the perforated pipes.
- The drainage pipes to the sizes shown on the drawings shall be prefabricated subsoil drainage system or similar approved type. PVC pipes with drilled holes will not be permitted. Drainage pipes shall be laid to the lines to the falls shown on the drawings and accurately boned in to correct gradients before backfilling.
- All pipe junctions shall be as supplied by the selected manufacturer and shall be fitted to the manufacturer's instructions to provide smooth flow and to fit the correct pipe sizes. Where changes in pipe diameters occur the correct junctions shall be used to match the changed pipe diameters.
- Connect drainage system to percolation pits.
- Where subsoil drainage pipes pass under paths or structure the pipe shall be of non perforated pipe joined at either end to the perforated pipe, and be surrounded by 100mm of concrete haunching.
- Trenches shall be backfilled to within 100mm of the finished level with clean coarse grained sand or crushed stone chippings 8-12mm diameter free of any fine particles. The gravel backfill shall be lightly compacted in 100mm depth layers.
- All drains shall be tested on completion to ensure a satisfactory water flow. Any pipes that do not flow are to be taken up and re-laid at the Contractor's expense.
- After testing has been approved, remaining depth of the trench shall be filled with a layer of coarse grained sand up to the finished soil level (after final settlement). Where the top layer is specified as such, clean graded gravel 20-40mm stone

chippings free from fine particles shall be placed up to the finished surface mix, free from clay lumps or any item likely to inhibit drainage.

5B.2.4 Sub-Surface Drainage Layer for Podium Planters

- Drainage mat shall be 30mm thick mat or cell. Lay drainage mat over base of podium ensuring individual sections are close butted. Lay filter fabric over drainage mat and return 300mm up walls. Overlap filter fabric by 300mm along seams and bond with filter fabric cement. Spread 50mm sand blinding layer, over filter fabric.
- Filter fabric shall be of approved make, as specified in this document. This shall be laid over the drainage mat and turned up the sides of the planter boxes 300mm.
- Filter fabric cement shall be an approved non-solvent bonding agent that will join filter fabric together. Submit manufacturer's technical data and sample for review.
- Sand shall be coarse washed river sand. It shall be free from soluble salts ranging in size so that 80-100% passes the 3mm sieve and 0.50% passes the 2mm sieve with 0% passing through a 1mm sieve.

5B.2.5 Landscape works: Softscape works

- **Scope of work**

The scope of services covers all horticultural operations and services including, labour, equipment, services and transport for all plant materials, Good earth, top soil conservation, manures, pesticides etc. completing the entire work within the scheduled time, maintaining the entire Softscaping work for one year after virtual completion of the work.

The Contractor shall refer to Specifications provided in this document for relating to formation levels, sub-bases, concrete footings, foundations and all associated works. The specifications are to be read along with necessary specifications from other PMCs.

Vendors' shop drawings shall be submitted for all such items where the Contractor will procure and install items from/by a reputed vendor. Execution of all such items shall be done after such drawings are approved by the Authority/ Authority's representative.

Contractor shall prepare and issue all required working drawings and get them approved by Authority/ Authority's representative with required number of revisions till the details provided do not satisfy the Authority/ Authority's representative.

Defects Liability Period (DLP) shall be of one year after completion of Landscape Execution. The Contractor will maintain the entire landscape development area free of cost for a period of one year after completion of all above works as certified by the Authority/ Authority's Representative's in consultation with the Landscape Architect

- **Special Condition**

The Contractor will have to provide the following items at no extra cost to Authority:

- a. The Contractor will supply and install 3.0 metres high barricades for safeguarding landscape development area and works, as indicated in the drawing. He may also install the barricades in the landscape development area according to his own understanding if he feels that any part of the landscape area is bound to be damaged for any reason, after taking prior permission from the Authority/ Authority's Representative.
- b. The Contractor will supply, install and maintain at his own cost, the most modern, automated watering system for the landscape, which will take care of the requirement for particular plants, save water and does not waste water, including any requirements specified by the Landscape Architect appointed by contractor. He will give full details of the layout, size of the pipe, size of the sprinklers, bubblers, etc and their warranty period. All equipment must conform to international standards and / or Indian Standards if available. The design of the irrigation system has to be approved by Authority/ Authority's representative.
- c. All equipment required for development shall be made available by Contractor, and its maintenance shall be his responsibility. This includes Tagara, Phawdas, Hose Pipes, Ground Roller, Manual and/or Electric lawn Mowers, Sprinklers, etc.
- d. Contractor will ensure that all plants remain free of diseases, pests, etc during development and maintenance periods. The contractor shall, without any additional charge renew any dead or defective plant material and shall fully maintain including watering, de-weeding etc. of the whole landscape as mentioned above.
- e. The Contractor shall maintain Nursery at his own cost at designated locations as shown in the drawing or at a suitable location within the plot as directed by Authority/ Authority's Representative. The Nursery will be fenced with gates for protection from cattle. The area of Nursery will be approximately 5000sqm. The item would include construction and maintenance of Green Houses if required.
- f. Contractor shall follow pre-construction and during construction soil erosion control measures as per the NBC Part 10, section 1, Chapter 4 – Protection of Landscape during Construction.
- g. The contractor in co-ordination with the Authority as applicable shall ensure conservation and storage of top soil: Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services. It shall be stockpiled to a height of 400 mm in designated areas and shall be re-applied to site during plantation of the proposed vegetation. Topsoil shall be separated from sub-soil debris and stones larger than 50 mm diameter. The stored topsoil may be used as finished grade for planting areas. It is the landscape contractor's responsibility to conserve top soil that is not disturbed by the civil contractor.
- h. The Contractor shall:
 - ✓ Furnish the source of top soil to Authority/ Authority's Representative.

- ✓ Study the soil report provided with the tender document, providing soil details such as pH, alkalinity, total soluble salts, porosity, sodium content and organic matter.
- ✓ Use the restored soil at site for landscape purpose, manure mixture, Neem cake, weedicide shall be added if required.
- ✓ Not consider any external soil source unless the existing soil conserved from site is lacking in quality and/or quantity.

Soil Analysis for Top Soil fertility determination

- ✓ To determine the fertility of top soil for conservation, soil investigation shall be carried out by an NABL accredited laboratory.
- ✓ Adequate number of test samples of soil from a depth of 10-200mm below ground level shall be collected from at least 5 representative locations from site, preserved and transported (as per standard procedures specified by the laboratory) carefully to the laboratory for carrying out necessary tests.
- ✓ All relevant Indian Standards for sampling and conducting laboratory tests shall be followed.
- ✓ This soil samples shall be analyzed to determine soil type, texture, total organic content, pH, extractable nutrients such as nitrogen, phosphorus, potassium, salinity, cation exchange capacity, % base saturation and extractable heavy metals.
- ✓ The soil analysis report from the laboratory shall also include a statement on the fertility and suitability of the soil for plant growth based on the analysis, in addition to the test results.

Top Soil conservation

- ✓ Topsoil shall be removed for conservation to a depth of 200 mm (not more than 400 mm) and shall be separated from subsoil debris and stones larger than 50 mm diameter.
- ✓ It shall be stockpiled to a height of 400 mm in designated areas. The stockpiled topsoil shall be protected from erosion during storage by installing earthen berms/solid walls, temporary seeding (using native grass), covering with mulch or plastic, etc.
- ✓ The topsoil shall be protected with sand bags/solid walled enclosures (2 feet high) on all sides for containment.
- ✓ Appropriate drainage channels shall be dug around the storage area to prevent flooding of the top soil storage area.
- ✓ The top soil shall be reapplied to site during plantation of the proposed vegetation as finished grade for planting areas.

- ✓ Seeding will take place immediately after re-spreading topsoil and decompacting, unless timing is inappropriate (for e.g., not in mid-summer).
- i. The contractor to identify erosion prone areas on site and protect them from construction activities throughout the construction period. Prevent / mitigate the disturbances caused to site due to construction activity.
- j. The contractor shall execute a sedimentation and erosion control plan that conforms to the best management practices highlighted in the National Building Codes of India (NBC) Part 10, section 1, Chapter 4 – Protection of Landscape during Construction. This standard describes two types of measures that can be used to control sedimentation and erosion. Stabilization measures include temporary seeding, permanent seeding and mulching. Structural control measures include earth dikes, silt fence, sediment trap, and sediment basin. All of these measures are intended to stabilize the soil to prevent erosion.
- k. The erosion and sedimentation control plan must be approved by Authority/ Authority's Representative and the erosion sedimentation control plan must be maintained throughout the execution period.
- l. The contractor shall execute measures of protection and preservation of existing landscape on site during entire construction time.
- m. Design, execute and maintain a temporary storm water management layout for the duration of construction activity. The storm water management layout should conform to National Building Codes of India (NBC) Part 10, section 1, chapter 4 – Protection of Landscape during Construction.
- n. Contractor should take measures to prevent entry of any soluble/ insoluble construction waste to enter the water table/ water ways/ ravines on site.

- **General Specifications**

- a. Holding Nursery
 - i. A piece of land has been secured within the site for use as a holding nursery as indicated on the Contract Drawing.
 - ii. As a holding nursery the Contractor shall provide all necessary plant and equipment to store his plant material, machinery and equipment for the duration of the contract, including the two-year maintenance period.
 - iii. The Contractor shall be required to install and establish all equipment that may be required to run a major landscape contract and ensure plant materials remains in a healthy and fit condition. The list of requirements includes, but is not limited to:
 - Provision of a 3,000 high tensioned chain link fence (with at least 2 no. lockable gates) around the extent of the holding nursery)

- Grading and laying of crusher together with associated storm water drainage to take vehicular loading
 - Provision of all site utilities including water, telephone, electricity
 - Provision of any shade structures that may be required to maintain the plants in a healthy condition prior to planting out
 - Provision of any irrigation systems, pumps, sprinklers that may be required to maintain the plants in a healthy condition prior to planting out
 - Provision of a site office to include at least one conference/meeting room capable of comfortably accommodating 15 persons
- iv. The Contractor may wish to use the holding nursery for the purpose of propagation of plant stock for the contract. This is not a mandatory requirement since it is assumed that plant stock will need to be outsourced in order to meet the programme target dates. The decision to use the holding nursery as a propagation area rests entirely with the Contractor having taken into account the programme constraints, the nature of the site location (relatively remote) and his own commercial considerations.
- a. Provision of Site Utilities
- i. The Contractor is to allow for the provision at his own cost of all site utilities for the duration of the contract including but not limited to water, electricity and telephone.
- b. Landscape Development Technique
- i. The contractor will not be allowed to use different techniques or quality criteria or materials unless his alternative system has been confirmed in writing by the Authority/Authority's representative.
- ii. No cost increases for alternative specifications will be entertained unless formally submitted in writing as an improvement in the quality of a product and accepted in writing, following Authority/Authority's Representative approval, by the Authority/Authority's representative.
- c. Quality of Workmanship and Materials
- i. All materials and workmanship shall be of the high standards and quality demanded by this specification. Sub-standard work and materials identified by the Authority/Authority's representative will be rejected and will be required to be rebuilt or replaced at the Contractor's costs.
- ii. All plant material shall be of the genus, species and variety specified and substitutions will not be permitted unless authorized in writing by the Authority/Authority's

representative. The sizes and plant description set out in the section headed Plant Material.

- iii. All trees and shrubs supplied for the contract shall be free of pest, disease, discolouration and damage. Plants shall be well branched with vigorous shoots. The root system of each plant shall contain a good proportion of fibrous roots.
- iv. All materials are to be approved by the Authority/Authority's representative prior to use on site. Materials shall be obtained from approved sources/manufacturers and/or suppliers. All guarantees and warranties shall be copied and submitted to the Authority/Authority's representative prior to requests for approval.
- v. Where particular products are specified, the Main contractor's specialists subcontractors if he wishes to use similar products from other manufacturers must seek prior confirmation from the Authority/Authority's representative.

d. Site Responsibilities

- i. From the commencement of the works until the Certificate of virtual Completion has been issued by the Authority/Authority's representative, the Main contractors specialists' subcontractors shall, in respect of all areas of soft landscape works, adjacent areas and parts of the site used by him, be responsible as follows:
 - For adequate protection to grassed areas, planted areas and trees and for making good Softscape works on removal of any protective measures at completion.
 - For any damage to existing works and features and any necessary rectification work required to obtain approval from Authority/Authority's Representative.
 - For keeping all paved surfaces used by him in a clean and tidy condition.
 - For periodic removal of all surplus excavations and waste matter produced by his operations to a Local Authority registered tip off site, to be found by the Main contractors specialists' subcontractors.
 - For keeping all Softscape areas in a weed-free and tidy condition and adequately watered.
- ii. The Main contractor's specialist subcontractors shall make appropriate allowance for these requirements in his rates.
- iii. The Main contractor's specialist subcontractors shall, within 24 hours of notification and as directed by the Authority/Authority's representative, undertake at his own expense any remedial works arising from the stated requirements.
- iv. Tree conservation:
 - All trees to be conserved shall be protected with a 3-4 foot high enclosure constructed using brick/fencing (with an access gate for tree maintenance) at a distance indicated in the table below depending on the diameter of the tree trunk.

TRUNK DIAMETER (measured at 4.5 feet above natural grade)	DISTANCE FROM TRUNK ON ALL SIDES
Up to 6 inches	Past dripline
6-9 inches	5 feet
10-14 inches	10 feet
15-19 inches	12 feet
over 19 inches	15 feet

- This tree enclosure shall be erected before demolition, grading, or construction begins and remain until final inspection of the project. A 'Warning' sign of size 8.5"x 11" shall be prominently displayed on each protective enclosure to state the following:
- The following activities are prohibited within and in the vicinity of the tree protection zone throughout the entire duration of the construction project:
- Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches, or other miscellaneous excavations
- soil disturbance or grade change
- drainage changes
- storage of material, topsoil, vehicles, or equipment
- Activity including but not limited to compaction, grading, construction etc.
- dumping of any material including but not limited to paint, petroleum products, concrete, mortar, dirty water, waste
- use of the tree trunks as a backstop, support or anchorage as
- a temporary power pole, signpost or other similar function
- The following activities are permitted or required within the Tree Protective Zone with approval from Landscape Architect:
- Mulching with wood chips (unpainted/untreated) or approved material to a four to six inch depth, leaving the trunk clear of mulch to prevent inadvertent soil compaction and moisture loss.
- Irrigation, Aeration, fertilization indicated by Landscape Architect for the healthy growth/maintenance of the tree
- if tree is adjacent to or in the immediate proximity to a grade slope of 8% or more, erosion control measures shall be installed outside the Tree Protection Zone to prevent siltation and/or erosion within the zone

e. Plant Protection

- i. All plant material is to be carefully protected and if necessary wrapped in the nursery during lifting, awaiting transportation, during transportation, unloading and during storage on site.
 - ii. Any evidence of unsatisfactory protection to roots, stems, branches and leaves will result in plants being rejected.
 - iii. Unprotected plants must not be transported during very hot weather, and all plants must be kept moist during transportation and storage. No plant material shall be left on site unplanted for more than two days.
- f. Work by Machine or Hand
 - i. All operations herein described shall be carried out by suitable approved machines or by hand.
 - ii. Any work around the base of existing trees, in confined spaces or which is impractical to carry out by machine for any reason shall be executed by hand and the contractor shall include for this in his rates.
- g. Notice of Intentions
 - i. The contractor shall give forty-eight hours written notice to the Authority/Authority's representative of his intention to commence any of the following operations:
 - Setting out,
 - Planting,
 - Topsoiling,
 - Turfing,
 - Sprigging,
 - Maintenance visits
- h. Heavy Machinery
 - i. Heavy machinery, which would excessively consolidate the sub-soil, shall not be used during any operations nor shall heavy machinery be taken over areas prepared for planting or grassing.
- i. Substitutions
 - i. If the Main contractor's specialist subcontractor is unable to supply a particular species of plant he is to notify the Authority/Authority's representative in advance of his intention to make a substitution. No substitution will be allowed without prior written agreement of the Authority/Authority's representative.

- ii. Notices of substitutions are to be made sufficiently for in advance of installation to ensure that the substituted material conforms to specifications. Substitutions requested by the Main contractor's specialist subcontractor after work has started on site will not be entertained.

j. Setting Out

- i. The Contractor shall be responsible for accurately setting out all the works prior to the commencement of the works and shall rectify errors in setting out at his own expense.
- ii. Any discrepancy in site area between that shown on the drawings by Landscape Architect appointed by contractor and the actual area on the ground shall be notified to the Authority/ Authority's representative.
- iii. The Contractor shall supply all necessary materials, equipment and labour to enable the Landscape Architect to check the setting out, levels and dimensions on the site along with the Authority/ Authority's representative.

k. Tools and Equipment

- i. The Contractor shall use proper tools and equipment for the carrying out of the works and is to ensure that the work force is fully and properly equipped with the correct equipment and experience for the job at hand.

l. Failures of Plants (Pre-practical completion)

- i. Any trees, shrubs, grass or other plants (other than those found to be missing or not in accordance with the Contract Documents as a result of theft or malicious damage and which shall be replaced), which are dead, dying, missing or found not to have been in accordance with the Contract Documents at practical completion of the Works shall be replaced by the Contractor entirely at his own cost unless the Contract Administrator shall otherwise instruct.
- ii. The Contract Administrator shall certify the dates when in his opinion the Contractor's obligations under this clause have been discharged.

m. Plants Defects Liability and Post Practical Completion Care by Contractor

- i. Any grass which is found to be defective within 24 months, any shrubs, ordinary nursery stock trees or other plants found to be defective within 24 months and any semi-mature, advanced or extra large nursery stock trees found to be defective within 24 months of the date of virtual completion due to materials or workmanship not in accordance with

the Contract Documents shall be replaced by the Contractor entirely at his own cost unless the Contract Administrator shall otherwise instruct.

ii. The Contract Administrator shall certify the dates when in his opinion the Contractor's obligations under this clause have been discharged.

iii. Malicious Damage or Theft (Before Practical Completion): All loss or damage arising from any theft or malicious damage prior to practical completion shall be made good by the Contractor at his own expense.

n. Submittals

i. The Contractor shall submit for review drawings by Landscape Architect appointed by contractor completely dimensioned, indicating any pattern layouts, special installation procedure, cutting, fitting, sinking and adjacent equipment materials for coordination.

ii. The Contractor shall submit samples of all materials and samples of workmanship for approval by Authority/Authority's representative.

iii. The Contractor shall be responsible for producing and submitting for comment and approval to the Authority/Authority's representative the shop drawings and samples of all elements indicated in this section. All should be based on the drawings provided by Landscape Architect appointed by contractor. All submissions should be reviewed, approved and endorsed by the Contractor.

o. Handling, Storage And Delivery

i. The Contractor shall:

- Coordinate delivery with suppliers, to minimize handling.
- Handle and store equipment and materials in such a manner that no damage will be done to the materials or the work of other trades.
- Store packaged materials, undamaged in their original wrappings, or containers with manufacturer's labels and seals intact.
- Stack equipment and materials on wooden platforms at least 150mm clear of the ground and protect with weatherproof covers.
- Damaged equipment, material or works will be rejected by the Authority/Authority's representative whether built-in or not.
- For equipment, materials and work, covering shall be of suitable material containing nothing that may injure or stain the materials.

p. Protection of Work

i. The Contractor shall protect all equipment, materials and completed work from damage until final completion of the work.

ii. The Contractor shall remove and replace damaged work at no extra cost.

q. Reference Standards

i. The Contractor shall comply with all relevant Indian Standards, ASTM, British Standard Code of Practice, Draft BS or DIN Standard applicable to elements indicated in this section, the recommendations and requirements of such documents shall be considered a minimum standard of such work described and must be complied with.

ii. Nothing shall relieve the Contractor of his responsibility for providing a higher standard than the relevant Code or Standard where it is required to comply with other sections of the Specification.

5B.2.6 Plant Materials and Planting Operations

The following plant descriptions cover the different categories of plant material to be used on the site.

These descriptions and their accompanying drawings requirements must be studied carefully and adhered to.

Plants that do not reach the specified dimension or quality, characteristics in this section or in the sizes and descriptions set out in the Bill of Quantities will be rejected and will have to be replaced at the Contractor's cost.

Trees and palms and large feature plants that are growing in open ground are to be prepared for transplanting at least 2 months before moving, either to containers in the nursery or direct to the site.

Preparation of in-ground trees and palms shall be by root pruning to the stated rootball dimensions.

Trenching around the outer edge of the rootball using pruning and a sharp spade shall be done in four separate stages trenching in quarters, with one quarter of the tree roots being cut and backfilled each week, the next quarter the following week, with all of the ball being cut in one month.

If roots over 25mm are encountered these are to be cleanly cut with large secateurs or pruning saw.

The trench which shall be at least 200mm wide shall be dug to the full specified depth of the rootball and undercut at the end of the root-pruning exercise to sever base roots.

The whole trench shall by this time be backfilled with sand. The tree is then to be allowed to settle for one month before final wrapping with protection and lifting. The rootball is to be well watered during this period.

For trees and palms that are to be containerised or root wrapped, the lifting and placing in containers or being wrapped is to be done immediately after the root trenching operation is complete.

Plants to be transported or moved are to be thoroughly wrapped and protected prior to transporting.

Rootballs are to be wrapped and tied with Gunny sack or hessian sacking if not containerised.

Exposed trunks are to be wrapped in rice straw including the lower parts of the branch system.

The upper branch system, especially if well furnished with leaves and twigs during transportation is to be completely wrapped in Lightweight netting or cloth tied and palms are to be laid at an angle to prevent damage from overhead structures and from buffeting and shall be covered by canvas as protection from wind.

Damaged trees will automatically be rejected on arrival at site.

All trees and palms are to be purchased, stored and grown on in suitable nursery conditions within one month of the contract and made ready for direction by the Landscape Architect appointed by Contractor.

Failure to procure within this time and to reveal the source of supply and location will result in the Authority/Authority's representative sourcing the plant materials for the Contractor, and the cost of this sourcing operation will be deducted from the Contractor's payments.

All dimensions shown with tolerances (that is 120 - 150mm) refer to maximum and minimum dimensions that will be accepted. Measurement of all plants of one species shall, as a minimum, average between the upper and lower figures (that is in the above case 135mm).

All trees and palms specified for contain rising or root wrapping after root pruning operations are to be well furnished with leaves over the crown of the tree. Thinning of leaves to reduce transpiration to give a 50% cover is permissible providing due notification is given that thinning is required to ensure that the trees can be inspected before thinning work is done. Bare crowned trees will not be permitted.

Leave cover: Any trees or palms which shed their leaves within 2 weeks of transplanting are to be replaced by the Contractor at no extra charge.

- Trees

- a. Instant Trees

These are semi-mature trees especially prepared in advance for transplanting.

Root pruning to cleanly cut roots to the diameter of the rootball shall be carried out 3 months in advance of transplanting.

Trees shall be 300 - 450mm (12" - 18") circumference of stem when measured 1.0m (3') from ground level and shall have a clear stem of minimum 1.8 metres.

The head shall be well balanced and contain at least four main branches 500-1000mm long giving an overall height of 3 - 4m after pruning.

All saw cuts are to be painted with an approved insecticide/fungicide solution.

b. Extra Heavy Standard Trees (EHS)

These are large size nursery grown trees pruned during growth to produce a tight well rounded head and a straight stem clear of leaves or twigs.

Trees shall be 140 - 180mm circumference of stem when measured 1m above ground level and shall have a clear straight stem of minimum 2m.

The head shall be well balanced and rounded and contain at least four main branches, and a well developed secondary branch system giving an overall height of 4.5 - 4.8m at the time of planting.

Trees shall have a defined central leader. Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 750mm x 600 deep minimum. Branching/leaf spread shall be of 2.2 - 2.4m diameter.

c. Heavy Standard Trees

These are large size nursery grown trees pruned during growth to produce a tight well rounded head, and a straight stem clear of leafs or twigs.

Trees shall be 120 - 150mm (5" - 6") circumference of stem when measured 1.0m (3') from ground level and shall have a clear straight stem of minimum 1.8 metres.

The head shall be well balanced and rounded and contain at least four main branches with a well developed secondary branch system and a central leader, giving an overall height of 3.5 - 4.0m (10' - 13') at the time of planting.

Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions, trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 600mm (2') x 450mm (1'6") deep minimum. Branching/leaf spread to be of 1.8 - 2.0m diameter.

d. Standard Trees

These are medium size nursery grown trees pruned during growth to produce a tight well rounded head, and a straight stem clear of leaves or twigs.

Trees shall be 100 - 120mm circumference stem when measured 0.9m from ground level and shall have a clear straight stem of minimum 1.5m.

The head shall be well balanced and rounded and contain at least four main branches with a well developed secondary branch system and a defined central leader that has not been pruned, giving an overall height of 2.5 - 3.0m at the time of planting.

Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions, trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 500mm (1.6'') x 300mm (1') deep minimum.

Branching/leaf spread shall be of 1.5 - 1.8m diameter.

e. Standard Feathered Whips

These are medium sized nursery grown trees having a single straight stem and unbroken leader giving an overall height of 2.5 - 3m.

The stem shall be fully furnished with evenly spread and balanced lateral branches down to ground level and shall be 80 - 100 mm circumference of stem when measured 1m from ground level.

The tree shall have a strongly developed fibrous root system and shall be container grown. Leaves or branches shall not be cut off before planting.

Rootball dimensions 450 x 300mm minimum. Branching/leaf spread shall be of 1.5 - 1.8m diameter.

f. Ships/Saplings

These are young tree grown from seed or cuttings which are trimmed or pruned, furnished with branches down to ground level.

Trees shall have a single straight stem and unbroken leader between 900 - 1500mm overall height.

Stem thickness will vary between species, but a strong stem which does not bend over is required.

The tree shall have a strongly developed fibrous root system and shall be container grown. Leaves shall not be cut before planting.

Container dimensions: 250mm diameter x 250mm deep minimum.

• Palms

All palms shall be single stem. Single Stem Palms shall have clear straight trunks of heights as stated in the Bill of Quantities as measured from the root collar to the base of the lowest leaf sheath. The stem girth shall be of dimension normally found for palms for the stem height and species specified.

Acceptable tolerances to variations in stem height shall be +200mm or -200mm from the height specified in the Bills of Quantities.

The heads of palms shall be well balanced with at least 7 leaves and a healthy growing apical shoot all free from pest and disease.

a. Rootball dimensions shall be in proportion to stem heights as follows:

Stem height	Rootball diameter	Depth
1m	400mm	400mm
2m	750mm	600mm
3m	900mm	600mm
4m	1200mm	750mm

• Shrubs, Herbaceous Plants and Ground Covers

a. Shrubs

These are woody perennials of generally multi stemmed and bushy habit ranging from 3 - 4.5m down to 500mm height.

Shrubs shall have no less than three main stems and shall be well balanced and bushy, with strongly developed fibrous root systems, and shall be pruned in advance as required to achieve the specified height tolerances.

Branches shall break from the base of the plant just above the root collar, and shall be well furnished with leaves right down to ground level.

All plants are to be container grown in containers of suitable dimensions for the species.

b. Herbaceous Plants

These are non-woody perennials usually of a clump forming habit.

Plants shall have a well developed main stem or stems with good symmetry, a healthy root system, free from pest or disease.

Clumps of herbaceous plants shall include rhizomes, corns, tubers or roots and soil undisturbed by lifting with evidence of growing shoots emerging above soil level.

All herbaceous plants are to be grown in containers unless specified as being produced by alternative method.

c. Groundcover plants

These are low growing, 500mm or less, or prostrate shrubs or herbaceous plants whose habit is to totally cover the soil.

All groundcover species shall be evenly balanced to allow equal growth in all directions.

Plants shall have fully developed roots and leaves.

Rooted cuttings will not be accepted. All plants to be container grown.

Rooted shoots of certain spreading ground cover plants shall be used only where specified, planted as 'sprigs' as opposed to established plants in soil.

Plants shall be rooted shoots and shall have at least one and evidence of vigorous root growth.

Recent cuttings with no root development shall not be acceptable.

d. Climbers

Climbers are plants whose growth habit is to climb upwards by means of twinning stems, tendrils or clinging roots.

Plants shall be grown to reach the recommended size using stocks no less than one year old, and no more than five years old at the time of the start of the contract.

Plants shall have at least two leader shoots up to the recommended height and a vigorous root system.

All plants to be container grown.

- Hedging Plants

Hedging Plants shall be shrubs such as Lawsonia, Ixoras, etc as per design requirements of Landscape Architect appointed by contractor as suited to regular clipping, previously prepared to establish a uniform height and complete foliage cover to the stem from ground level upwards.

Plants shall be a minimum overall height of 500mm with a minimum of 4 branches arising from ground level and a strongly developed fibrous root system.

Branches shall be well clothed in leaves down to ground level.

All plants to be container grown in suitably sized containers.

Hedging plants shall be prepared by root and branch pruning to achieve the 'box' shape shown, at least 3 months before transplanting.

- Container Grown Plants

Container grown plants shall mean trees and shrubs which have been grown in containers sufficiently large to hold the developing root system from seed or cutting and shall be filled with suitable nutrient rich, free draining compost as per design requirements of Landscape Architect appointed by contractor.

Container grown stock shall be well watered prior to dispatch from the nursery and shall remain in the container until planted on site, whereupon the container shall be carefully removed to avoid soil disturbance.

Empty containers are to be removed from site.

- Cultivation of Plant Beds

Cultivation of the completed soil mix beds shall take place only when the seeding or planting operations can begin immediately after cultivation. No cultivation shall be undertaken in weather or ground conditions in which operations may destroy soil structure or where soil mix has not been approved by the Landscape Architect.

Cultivation shall be by approved mechanical or manual means to a depth of 250mm for Ground Cover and 450mm for Shrubs to provide an even, weed free texture.

After cultivation, stone picking from the surface of soil areas shall be carried out such that all stones and lumps exceeding 50mm in diameter are collected. All stones, weeds and rubbish brought up shall be removed from the site to a tip to be found by the Contractor.

Ground cover, rooted shoot and herbaceous beds are to have 25mm solid conditioner spread over the entire area and well forked in to the top 250mm of soil during cultivation. This operation is separate from the mulching specified.

5B.2.7 Planting Techniques and Accessories

All plants shall be planted to accommodate the spreading root system of the plant to the same soil depth as in the nursery and shall be well watered before removing them from containers. Plants are to be positioned upright and the soil firmed around the roots.

Planting shall be carried out in accordance with the schedule of plants and drawings supplied by Landscape Architect appointed by contractor. The number of each species and variety shall be evenly distributed over the area as indicated on the drawings by Landscape Architect appointed by contractor.

For large areas the outer rows are to be set out first to ensure the correct shape to the bed is established. The remaining plants are then to be evenly distributed to cover the planting area. The Landscape Architect is to be notified in advance if there are too many or too few plants to fill the area required and an assessment of setting out adjustments will be directed accordingly.

Setting out of plants is to be completed and approved by Landscape Architect appointed by contractor before planting into the soil bed can commence.

- **Small Shrubs, Herbaceous, Ground Cover and Root Planting in Beds**

Small shrubs, ground cover and herbaceous plants shall be planted in pockets formed by a trowel or spade.

The pocket shall be deep enough and wide enough to accommodate the root of the plant.

The sides and base of the pocket shall be loosened and the plant roots lightly loosened from the rootball.

The plant shall be placed upright in the pocket and firmed into the ground by backfilling and treading or hand pressure.

The topsoil in areas to receive rooted shoots shall be brought to a fine layer 75mm deep by approved mechanical means or hand raking.

Approved slow release fertiliser shall be applied evenly over the area at a rate of 40gms per square metre and shall be lightly raked into the surface.

Rooted shoots shall be firmly bedded into the soil at 75mm centres with each shoot spread on the topsoil surface, separated from adjacent shoots.

The area shall be top-dressed with finely sifted topsoil/compost mix as approved by the Landscape Architect appointed by Contractor to lightly cover the rooted shoots after laying.

The ground shall then be firmed by lightly treading or hand pressure around the roots, taking care not to damage the shoots, to ensure good contact with the soil.

Watering shall take place immediately after planting, using a fine spray.

The firmed up area is to be tightly cultivated after completion of this operation to leave an even layer before mulching.

- Shrub Pits

Shrub pits for large and medium shrubs, feature plants and climbers shall be excavated to 150mm wider on either side than the root spread, and to a depth of 150mm deeper than the root depth and shall not be less than 300mm x 300mm x 450mm deep.

The bottom 150mm of the pit is to be forked loose prior to backfilling.

Backfill material shall be topsoil Mix A for backfilling purposes.

The Contractor shall note that for planting into turf areas, where topsoil has not been spread topsoil mix will be required for backfilling purposes.

Climber pits shall be 150 - 200mm away from the supporting structure with the roots spread away from the wall or adjacent supporting structure.

The climbing plants shall be trained through the wire mesh with leading shoots directed upwards and tied.

Pits for shrubs and feature plants in planters shall be excavated to 150mm wider on either side than the root spread and to a total depth of the rootball.

The bottom of the pit shall be lightly formed, prior to planting taking care not to damage the terrain layer below.

After planting shrubs the area is to be watered immediately to bed the shrubs in.

Once the water has percolated away and left the surface relatively dry the soil area is to be lightly forked to loosen the surface and leave an even soil layer.

- Tree Pits

Tree pits shall be excavated to the dimensions and the location shown on the drawing by Landscape Architect appointed by Contractor.

Tree pits shall be dug a minimum of 3 weeks period prior to back filling.

The bottom of the pit shall be forked to loosen the soil. In case the soil is clayey, a layer of broken bricks and stones shall be spread on the bottom of the hole and this layer shall be covered with dried leaves or straw.

No tree pit shall be less than 300mm wider on either side than the root spread, and to a depth of 150mm deeper than the root depth, and shall not be less than 1m x 1m x 1m.

The trees shall be planted to the same depth in the nursery or as in their containers.

In case the site is infested with white ants the sides of the pits shall be brushed with a mixture of BHC (10% concentration) and water in a proportion of 200 gms of BHC mixed in 5 litres of water. BHC is the common name for the insecticide.

- Backfilling of Pits (trees, shrubs and climbers)

Before backfilling, imported topsoil and sand is to be thoroughly mixed with soil conditioner and organic fertiliser as specified for Topsoil Mix A. (Ref. Section 8-Part 1: 4.1.3 Soil Mixes)

The tree pit shall be backfilled with the Soil Mix A to a depth which will allow soil, after settlement to match surrounding ground level.

The filled pit shall be watered and allowed to settle. After settlement soil levels shall be topped up as required.

The centre of the backfilled tree pit shall be excavated large enough to allow placing of the rootball, and to allow even compaction all round during backfilling.

After careful removal of the container or wrapping, the rootball of trees shall be placed carefully in the pit, and soil replaced gradually into the pit.

The soil is to be consolidated during backfilling in layers to ensure that the plant is firmly held in the ground and that voids are not left around the roots.

Care shall be taken during planting to avoid damage to the root system, branches or leaves.

After careful removal of the container or wrapping, the rootball of the roots of shrubs and climbers shall be placed carefully and the soil replaced gradually in the pit.

The soil is to be consolidated during backfilling in layers to ensure that the plant is firmly held in the ground and that voids are not left around the roots.

Care should be taken during planting to avoid damage to the root system, branches or leaves.

- Staking and Supports

Stakes shall always be used when planting instant trees, standards and single stem palms and for tall shrubs when directed by the Landscape Architect appointed by Contractor.

Stakes shall be in sawn timber of an approved type and be carried out according to the size of plant to be supported. The types of approved staking methods are:

- a. Tripod or Quadropod staking for large trees or palms (extra heavy standard and above)

Three or four stakes each 50 x 50mm section shall be positioned equidistantly around the tree and firmly driven into the ground at angles of between 30 - 40 degrees.

The inner ends of the stakes shall extend beyond the tree stem by not more than 150mm and shall not be higher than 300mm below the lowest branch.

The tree stem shall be wrapped in hessian or gunny sacking at the point where the tree stakes are to be fastened in order to prevent bark damage.

The stakes shall be neatly and firmly fastened to the tree stem using rubber hose or cord; String are not be used.

The stakes are to be adjusted and the position of the protective wrapping is to be altered up or down every month.

The hessian wrapping is to be sprayed with an approved horticultural pesticide.

b. Multiple guying - for large trees or palms (heavy standard and above)

A minimum of three wire guys are to be used per tree.

Each guy wire is to be fastened by a loop around the lowest branches of the tree at the junction with the main trunk or branches of the tree at the junction with the main trunk or stem.

Loops are to have protective rubber or plastic hose to prevent chafing and are to be fastened back to the guy wire by means of U-clamps or bolts.

Guy wires are to be fastened at ground level to short stakes firmly driven at an angle into the ground.

Stakes shall be minimum length of 600mm and are to be driven deep enough to resist movement.

A notch is to be made near the top of each stake for the fastening of the guy wire.

Stakes shall be positioned equidistantly and equally around the tree and shall be at least 300mm beyond the extent to the tree pit.

Distance away from the tree shall be gauged on site to provide firm and secure guying.

Each guy wire is to have one turnbuckle located near the fastening to the stake.

Guy wires are to be kept in a proper tension and adjusted to maintain the tree in a vertical position without guy wires being rigid.

c. Double Staking - for trees and palms (heavy standard and smaller)

Two stakes each 50mm x 50mm cross section shall be driven into the ground in a vertical position on either side of and outside the rootball of the tree so as to form a straight line outside the rootball of the tree so as to form a straight line with the stem at the centre.

Stakes shall be driven in to penetrate the bottom of the tree pit and be deep enough to resist lateral movement when tested.

Stakes shall not extend beyond the lowest branch of the tree and if necessary are to be sawn off at the top.

Fastening or securing of the tree may be carried out by using either:

Cross bar

A wooden cross bar of same section as the stakes is fastened in a horizontal position to the outside of the stakes by nails or tying securely at a level below the lowest branch.

The tree is fastened to the cross bar with a single adjustable tie of an approved rubberised or plastic type with a spacer and shall be fastened to prevent any chafing or abrasion of the bark.

No nails or fixings are to be driven into the tree trunk.

i. Wire/Hose loops

Two separate wire or rope loops are made about the stem just below the lowest branch with each being fastened back to one of the vertical stakes.

Each loop is to have a protective outer covering or sheath of rubber hose to prevent chafing or abrasion of the bark.

The wire or rope is to be fastened to the stakes in a manner that allows adjustment of the tension to be made easily.

Tension on each wire is to be equal to maintain the tree in a vertical position.

Where directed by the Landscape Architect appointed by Contractor the tree may be secured with a second set of loops at a lower level.

d. Single Staking - for trees and palms of sapling size only

A single stake of cross section 50mm x 50mm is driven vertically into the ground 150mm - 250mm away from the tree.

The stake is driven down beyond the base of the tree pit and shall be firm when tested.

The top of the stake shall be 100mm below the lowest branch.

Two ties of an approved rubberised or plastic type are to be used.

The top tie is to be located 100mm below the top of the stake; the lower tie 300mm from the base.

Ties are to have spacers to maintain the 150mm - 250mm distance between the stake and the tree.

Ties are to be fastened to avoid rubbing, chafing or abrasion of the bark.

e. Climber wires

Wires for training climbing plants against walls shall be approved lightweight PVC mesh, fixed at 600mm intervals to screw eyes supplied under the sub contract.

Maximum mesh coverage shall be 180mm high x 240mm wide.

The climbing plants shall be trained through the wire mesh with the shoots directed upwards and tied.

- Turfing

- a. Close Turfing

Close Turf shall be a live grass sod or mat at least 300mm square with a well developed root system growing in a minimum of 25mm soil bed, free from stones or extraneous roots, cut mechanically or by hand to give an extra thickness and texture.

A sample of one square metre of Turf shall be submitted to the Authority/Authority's representative for approval before Turf is brought in for use on site.

The source of the material shall be stated by the Contractor.

Turf shall be free from weeds, fungus, pest or disease and contamination or pollutants.

Turf sods shall be kept moist and in shade and shall be planted within 24 hours after lifting.

In exceptionally dry weather, the turf must be kept well watered at the nursery or turf farm in order to keep full green leave structure.

Dry, brown or wilting grass turf will be rejected and growth or recovery on site will not be permitted.

- i. Close Turfing: Ground Preparation

Rake the topsoil mix area to a smooth and uniform grade free of any slight mounds or depressions to achieve a uniformly flat surface.

Re-grade any depressions or humps that may occur until a satisfactory grade is achieved.

The area to be turfed is to be brought to a fine tilth by approved mechanical means or by hand raking.

Any stones over 25mm in diameter shall be removed from the site of turfing.

Watering of the area shall be carried out to produce a moist condition of the soil and to consolidate the soil.

If consolidation occurs to produce any areas with topsoil depths less than 100mm these areas shall have extra topsoil spread to produce finished levels.

Fertiliser shall be applied to all areas to be turfed prior to turfing at the rate of 40gm per square meter, evenly spread over the whole area and lightly worked into the soil.

- ii. Close Turfing: Operations

Close turf sods shall be laid onto the surface of the prepared ground with leaf turfs upwards, butt jointed as closely as possible to achieve a uniform cover.

The turf shall be laid off planks working over turves previously laid.

The whole area is then to be top dressed with finely sifted topsoil mix to give an evenly smooth surface. The finished close turfing shall be lightly compacted by treading or with a wooden beater to ensure even coverage and compaction.

Watering shall take place over the area that has been turfed immediately after planting. Watering shall be undertaken by use of a fine spray to avoid disturbance of soil particles.

Turfing shall be only accepted as complete after the growth of an even grass cover is evident. Any areas not covered by green healthy grass to the satisfaction of the Authority/Authority's representative within 28 days after turfing shall be re-laid as specified at the Contractor's own expense.

For the period of 28 days after turfing the vegetative cover shall:

- I. Evenly cover at least 90% of the areas with leaves and spreading shoots of specified grass variety
- II. be free of perennial weeds or disease
- III. be healthy and vigorous and showing a strongly developed root system

Should there be any settlement due to lack of even compaction this will be corrected by application of topdressing of finely sifted soil to maximum depth of 25mm.

If the depression is greater than 25mm the grass in the affected area shall be lifted, the depression filled with sifted topsoil, lightly compacted and the affected area re-turfed as specified. These operations shall be done as often as necessary to produce an even and smooth surface free from bumps and hollows.

All turfing operations shall be carried out from wooden planks or plywood boards, with the workers moving away from completed turfed areas, raking any compressed soil or footprints before laying of sods.

All access onto soil areas shall be on wooden boards or plywood sheets. Areas compacted by working are to be re-cultivated and re-laid.

iii. Maintenance of Close Turfing Before Completion

The following operations are to be carried out as often as required to achieve the specified quality of turf:

- I. Cutting before Completion shall be carried out as necessary to keep the grass to a maximum height of 30mm.
- II. Watering shall be carried out as often as necessary before Completion to allow a satisfactory green sward to develop over the whole close turfed area.
- III. One fertiliser application per month is to be carried out for before Completion.
- IV. Topdressing as specified as often as required to establish smooth even grades and levels free of hollows.

- V. If compaction or consolidation takes place or hard passing or baking of the soil occurs, the soil areas are to be well watered first and lightly loosened by mechanical means such as spiking, slitting or hollow tinning using approved equipment.
- VI. Completed close turfed areas are to be kept in a weed free insect free, fungus free and tidy condition until Completion (that is start of maintenance period).

iv.Sourcing of Turf Types

Close turfing materials are to be obtained from a bona-fide horticultural source or private land Authority.

No turf is to be removed from unauthorised locations, roadside, riverbanks or private property without permission of the Authority.

The Contractor is to inform source of all turf delivered to the Authority/Authority's representative before any turf is laid at site.

b. Fine Turf

Fine Turf shall consist of fine bladed rhizomatous grass such as Bermuda grass or cultivar specified by Landscape Architects appointed by the Contractor.

Fine Turf shall be a live grass sod or mat at least 300mm square with a well developed root system growing in a minimum of 25mm soil bed, free from stones or extraneous roots, cut mechanically or by hand to give an even thickness and texture.

A sample of one square metre of Fine Turf or both types shall be submitted to the Authority/Authority's representative for approval before fine Turf is brought in for use on site.

The source of the material shall be stated by the Contractor.

Fine Turf shall be free from weeds, fungus, pest or disease and contaminants or pollutants.

Fine Turf sods shall be kept moist and in shade and shall be planted within 24 hours after lifting.

i.Fine Turfing Operations

Subsoil mix shall be hand raked to provide an even and fine tilth to an even and accurate level matching kerb edge levels.

Any lumps or stones over 25mm in diameter brought up in this operation shall be removed from site.

Soil areas shall be lightly sprinkled with water to moisten surface in dry weather before laying turf.

Pre-Turfing fertiliser shall be applied to all areas to be turfed prior to turfing at the rate of 40gm per square metre evenly spread over the whole area and lightly worked into the soil.

The turves shall be laid on the prepared soil bed and firmed into position in consecutive rows with broken joints, closely butted and to the correct levels.

The turf shall be laid off planks working over turves previously laid.

Where necessary, the turves shall be lightly and evenly firmed with wooden beaters, the bottom of the beaters being frequently scraped clean of accumulated soil and mud.

A dressing of finely sifted topsoil/sand/compost mix shall be applied and well brushed into the joints to give an overall even surface.

Watering shall take place over the area that has been turfed immediately after planting. Watering shall be undertaken by use of a fine spray to avoid disturbance of soil particles.

Fine turfing shall only be accepted as complete when new growth has caused turves to knit together and adhere by rooting to the soil bed.

Any areas not covered by green healthy grass to the satisfaction of the Landscape Architect within 28 days after fine turfing shall be re-laid as specified at the Contractor's own expense.

If shrinkage occurs or the joints open, finely sifted topsoil/ sand/ compost mix shall be brushed into the gaps and shall be watered in.

Any inequalities in finished levels owing to variation in turf thickness or uneven consolidation of soil shall be adjusted by lifting turves and by re-spreading fine soil mix to correct levels and relaying turves as specified.

The finished level of the Fine Turf shall be 25mm above adjoining paved surfaces or other hard edges after allowing for final settlement.

Turf edges and margins shall be laid with whole turves and uneven edges trimmed to give an even line.

ii.Maintenance of Fine Turfing before Completion

Watering shall be carried out as often as necessary before completion to allow a satisfactory green sward to develop over the whole fine turfed area.

Cutting before completion shall be carried out as necessary to keep the grass to a maximum height of 25mm.

One extra fertiliser application is to be allowed for before completion, to be used if directed by the Landscape Architect appointed by Contractor.

Completed fine turfed areas are to be kept in a weed free insect free, fungus free and tidy condition until completion (that is start of maintenance period).

Edge cutting shall be carried out as required along edges of paths, plant beds or other junctions with other materials. Only sharp edge cutting tools are to be used for this operation.

Over cutting or ragged edges will require the relaying of the turf edge strip as specified (that is 300mm wide).

iii.Specification for Sourcing of Turf Types

Fine Turf is to be specially prepared horticultural turf, re-lawn or turf-carpet, mechanically cut to specified tolerances.

c. Slope retention work with Coir Mat Turfing

i. Site Preparation

Sub-grade shall be excavated to proper lines and grades based on construction plans.

The sub-grade shall be fairly smooth and free of sharp objects and debris that may damage the Coir Mat.

The soils should be proof rolled prior to Coir Mat and backfill placement.

The soils should be compacted to 95 Percent of the relative density based on the Site PMC's recommendations.

Above the compacted soil, Top soil mix 'A' to be laid upto 150 mm thick layer for planting turf.

Coir mat to be laid first and then planting operation should take place.

ii.Laying of Coir Mat

Coir Mat should be placed in correct orientation as shown on the construction plans and approved by the PMC.

The Contractor should verify the orientation. The orientation of the Coir Mat should be such that it is rolled in the direction of the slope – not perpendicular to it.

The Coir Mat should be cut to length based on construction plans using an PMC approved cutting tool.

Each sheet of Coir Mat should be pulled taut by hand to get rid of any wrinkles.

Adjacent sheets should be overlapped for minimum width of 0.30 M.

Each sheet may be secured in place using staples, pins, sandbags, backfill, or by other PMC approved methods to help prevent disruption during the installation of adjacent sheets.

iii. Turfing

Turfing should be done as per procedures mentioned above once Coir mat is installed.

- Watering of all Plants

After planting all plants are to be thoroughly watered to soak the ground all around the rootball.

After watering and the water has percolated away leaving the surface relatively dry the soil is to be lightly cultivated to give an even soil tilth.

- Mulching

After completion of planting and watering and light cultivation operations a 50mm deep layer of approved mulch shall be spread and forked in over all cultivated planting areas.

Around each tree and palm and around the base of each climber, additional mulch is to be applied to a 50mm depth to a diameter of 600mm.

Mulching is to be done within 2 days of completing planting and watering in.

- Fertilising

After a period of settling in of at least one month, all pit planted materials shall be fertilised with an approved slow release fertiliser at the rate of:

Trees : 250gm per tree

Shrubs/climbers : 50gm per plant

Ground Cover/Herbaceous : 100gm per square meter spread

Rooted Shoots : around the base of the plants - 40gm per square meter

All fertilised areas are to be watered immediately after fertiliser application.

- Disease Control

The Contractor shall take all necessary precautions to prevent or eradicate any outbreak of disease or insect attack.

- Planting into Turf Areas

Where planting is to be carried out in areas of turf, the turf shall be carefully cut to the size of the tree or shrub pit, rolled and stored for re-use, being kept moist and in shade.

After planting is complete stored turf shall be re-laid around the base of the plant.

The Contractor shall replace at his own expense, any turf which is damaged during planting operations.

- Protection of Planted Areas

The contractor shall be responsible for protecting all planted areas.

If it is necessary for the Contractor to erect protective fencing, the Contractor shall be responsible for keeping the fencing in position and in good repair until the end of the maintenance period.

Fencing proposals shall be submitted to the Authority/Authority's representative for approval.

Post and string fences shall not be acceptable.

- **Maintenance prior to Completion**

After planting and prior to the onset of the maintenance period, the Contractor shall be responsible for carrying out all necessary measures to ensure that the plant material thrives and becomes established and that the landscape areas are kept in a clean and tidy condition.

The Contractor shall allow for carrying out the following maintenance operations when necessary prior to the onset maintenance period, all as specified in section 6 of this specification:

- Replacement of dead/missing plants
- Grass cutting around trees
- Watering
- Cultivation and loosening of soil
- Weeding
- Pruning and clipping
- Firming up and adjusting stakes and ties
- Eradication of pest or insect attack
- Topdressing and mulching
- Fertilising

The Contractor shall be responsible for replacing any plants which fail to survive as a result of inadequate maintenance operations, poor workmanship or poor quality of plant material prior to completion.

The Virtual Completion Certificate will not be issued until all plants scheduled on the Drawings and Schedule of Works are installed in a healthy condition in the manner specified.

5B.2.8 Planting on Terrace

- Laying of Drain Cells

6.1.1 For planting at terraces, Drainage membrane/Drain cell matting (Colour : Black, Material: Poly Propylene, Size: 500mm x 250mm tiles of 20 mm thickness or

equivalent) shall be laid over the waterproofed terrace surface as per the vendor's guidelines.

6.1.2 The surface shall be cleaned and dried before starting installation.

6.1.3 Membrane shall be laid in the direction of slope and where necessary shall be cut to desired shape and form as per the Landscape design PMC's requirement.

- Laying Of Geo Textile Membrane

6.2.1 Geo-textile membrane (200 gsm or equivalent) shall be laid as root barrier over the Drainage membrane surface as per the vendor's guidelines.

6.2.2 Membrane shall be laid in only one direction along the width and where necessary shall be cut to desired shape and form as per the Landscape design PMC's requirement.

6.2.3 While laying minimum overlap of 100mm shall be maintained to avoid formation of any gaps.

5B.2.9 Maintenance Works

- General

- i. The Contractor shall maintain the landscape for a two-year period after the date certified by the Landscape Architect that the work has been satisfactorily completed (issue of Certificate of Completion).
- ii. The extent of the landscape to be maintained by the Contractor shall be deemed to cover and include all soft landscape areas within the overall project boundaries as shown on the drawings including all existing soft landscape not affected by the contract works and retained intact or nearly so through the end of the contract period as well as all the landscape works covered in the contract scope of works. No additional maintenance charges will be allowed unless specifically agreed to by the Landscape Architect in writing.
- iii. The Contractor shall ensure that a senior qualified supervisor is made available for organising and running the maintenance programme. The Contractor shall also have available an experience foreman who can supervise the workers on a day-to-day basis. An adequate trained labour force of at least 3 workers must be available for routine work and they must be on site for at least half a working day, 5 days per week during the maintenance period. Additional grass cutting operators will be needed to ensure adequate cutting and cleaning.
- iv. The Contractor's Supervisor shall inspect the site once per week during the maintenance period and shall prepare a brief schedule of operations required for the coming week. The format for the schedule of operations will cover each distinct areas of the site such

as frontage, rear, courtyard, roof, interior, etc. The schedule shall describe the operations the Contractor intends to carry out in the coming week to cover the items listed in the specification and to ensure that the current weather conditions and growing performances, insect attack, etc is taken into account.

- v. A copy of this schedule is to be submitted to the Landscape Architect and Authority every week so that a running record of proposed operations can be checked at the maintenance inspections each month. If in the opinion of the Landscape Architect the maintenance works have not been satisfactorily carried out according to site conditions and the specifications, part of the monthly payment will be withheld until the works have been satisfactorily carried out.
- vi. The contractor shall carry out all necessary measures to ensure that all pot plants, trees and shrubs and other plants shall thrive and become established within this period. All landscape areas will be inspected monthly and lists of remedial works issued after each inspection. All items on the remedial lists are to be carried out by the time of the next inspection, i.e. within one month.
- vii. The Contractor shall keep the landscape areas clean and tidy at all times and dispose of all waste materials arising from the cleaning.

- *Maintenance of Planted Areas: Trees, Shrubs, Climbers, Herbaceous and Ground Covers*

- i. The Contractor shall water all trees, palms, shrubs, ground cover, rooted shoots, herbaceous plants and other planting areas as often as necessary to keep the ground moist all around and to the full depth of the roots of the plants to a minimum depth of saturation of:
 - 100mm for groundcover
 - 300mm for shrubs
 - 750mm for trees
- ii. Fresh water only shall be used for the Works. Water shall be supplied to the Contractor from agreed points on the site. However, it will be only to necessary for the Contractor to supply his own means of transport from the watering points to the plant beds.
- iii. An inspection of watering requirements is to be made by the Contractor at least two times a week in dry weather.
- iv. Water shall be supplied using an approved hose or sprinkler so as not to cause compaction or wash-outs of the soil or loosening of plants. The Contractor shall immediately make good any such damage, soil erosion or outwash and plants loosened by erosion are to replanted or if damaged, replaced.
- v. All plant beds are to be kept in a weed free condition with a weeding operation once a month. All weeds, stones and rubbish collected from this operation shall be removed from the site to a tip to be found by the Contractor. Herbicides may not be used on this

site unless a specific application in writing is made by the Contractor with full back up data on the performance of the chemicals and the particular need for the chemicals use. Approval will in all cases be subject to the Landscape Architect's decision.

- vi. After weeding, at least once per month the soil surface is to be lightly broken up between plants using a pronged fork upto maximum depth of 100mm. Contractor shall Take care not to disturb the root systems of plants. After forking the soil loose, the mulch and loosened soil are to be raked to give an even re-distribution of the mulching materials
- vii. Firming up and adjusting of stakes/ties shall be carried out monthly to ensure that the trees and shrubs are firmly held in the ground. If required guy ropes or tree pits shall be adjusted, tightened or loosened. If tree ties or ropes are rubbing the bark of the trees, the ties are to be taken off and retied. Any damaged branches are to be carefully pruned and the wounds sealed.
- viii. All protective fencing is to be maintained and kept in good condition and in position until the end of the maintenance period.
- ix. Trees shall be pruned if dead, rotten or crossed branches are present or to maintain a clear stem up to the specified height using the methods described below. Tree pruning is to be reviewed monthly.
- x. All shrubs and ground covers are to be reviewed monthly and pruned as and when required during the Maintenance Period to promote bushy growth and good flowering characteristics. The shrubs shall be checked and all dead wood, broken, damaged or crossed branches shall be cut back, depending on species. Pruning and removal of branches is to be carried out using sharp clean implements to give a clean sloping cut with one flat face. Ragged edges of bark or wood are to be trimmed with a sharp knife.
- xi. Pruning for all plants shall be carried out as follows:
 - Pruning is to be done with the cut just above and sloping away from an outward facing health bud.
 - Removal of branches is to be done by cutting flush with the adjoining stem and in such a way that no part of the stem is damaged or torn.
 - Ragged edges of bark are to be trimmed with a sharp knife.
 - Any cuts or wounds over 25mm diameter are to be painted with an approved sealant after trimmed.
 - All pruning to be cleared up and removed from site after pruning.
- xii. All hedges, mat forming herbaceous plants and ground cover plants shall be clipped with shears as often as necessary (at least monthly) to maintain a tidy appearance. Tall hedges are to be cut to forms shown on the drawings. Fertiliser is to be applied to clipped areas around 1-2 weeks after clipping.
- xiii. Selective pruning of flowering plants shall be done where special flowering characteristics are required such as for Ixoras, Hibiscus, Allamanda where flowering takes places on twig ends. Heavy clipping must not be used for these species since this

will remove future flower buds. Selective pruning by clipping non flowering twigs and leaving flowering twigs is necessary for these plants, and this operation must be done by experienced workers.

- xiv. The Contractor shall allow for monthly fertiliser operations during the Maintenance Period. An approved slow release fertiliser shall be applied to each plant at the rate of 50gm per shrub and 200gm per tree, one month after planting and thereafter monthly. After spreading the fertiliser around the base of the plant the granules shall be lightly forked into the soil, and the plant well watered. Herbaceous and ground cover areas shall receive 25mm of approved soil conditioner, evenly spread and mixed with 50gm/m² of approved slow release fertiliser, evenly spread over entire area and lightly forked into the soil to break up the top layer, and the area well watered on a month by month basis.
- xv. The horticultural requirements of different plants or areas may involve variations to those techniques (such as the use of organic liquid fertilisers for sensitive plants) and variations in method will be authorised as required.
- xvi. Heavy feeding plants such as Canna, Heliconia and Lantana shall be dressed with a 25mm mulch of approved organic compost or similar approved compost every 2 months, lightly forked in around the base of the plants.
- xvii. Additional mulching layer, 25mm deep to be spread and forked in over all planted areas at 3 monthly intervals.
- xviii. The Contractor shall make regular weekly checks to ensure that the plant material is insect and pest and fungus free. No pesticides may be used unless approval from the Landscape Architect is given from the Contractor stating the chemical intended for use; concentration, spraying programme and including full technical details of the product.
- Maintenance of Lawn Areas
 - i. The Contractor shall mow all lawn areas using approved cutting equipment to maintain a close sward to a height of not less than 20mm and not more than 30mm for all grass types.
 - ii. Mowing shall be carried out generally weekly, except in dry weather and grass shall not be allowed to flower between cuts.
 - iii. Weekly inspections are to be made to ensure adequate planning of grass cuts to suit growth and weather conditions. All clippings to be gathered up and removed from site.
 - iv. All grass areas are to be watered by means of sprinklers during dry weather as often as is required to keep the grass green and the soil moist.
 - v. The Contractor shall provide hoses and sprinklers for use from water points provided. Weekly inspections are to be made to determine the need for water and, in dry weather watering must be done to moisten the soil to a depth of 100mm.

- vi. Fertiliser of NPK value 10-15-15 or similar approved be spread at a rate of 40gm/sq m over all grass areas at monthly intervals, using approved spreading equipment to give an overall even spread. Grass areas that have been fertilised shall be watered if no rain falls within 24 hours.
- vii. The Contractor shall apply top-dressing of not more than 15mm depth fine sand and granulated compost raked and spread evenly over the lawn areas. The next top-dressing shall be applied only after the grass has grown through to a mowable height.
- viii. There shall be at least two applications of topdressing during the maintenance period, to be directed by the Landscape Architect appointed by Contractor.
- ix. If depressions or bumps over 25mm deep or high in turf areas during the maintenance period these are to be levelled out by lifting the turf and raising the soil level with sand/compost mix or trimming to level grades, followed by re-turfing.
- x. Grass areas are to be kept free of weeds, annual grasses, fungus and insect attack and free of stones or other debris throughout the maintenance period as often as is required.
- xi. All chemicals used shall be to the approval of the Authority/Authority's representative. Assessment of these operations is to be prepared on the basis of the weekly maintenance inspection chart.
- xii. If compaction or consolidation takes place or hard passing or baking of the soil occurs, the soil areas are to be well watered first and lightly loosened by mechanical means such as spiking, slitting or hollow tinning using equipment approved by the Authority/Authority's representative.
- Replacement Planting
 - i. If during the course of the Maintenance Period trees or shrubs or other plants die because of a fault by the Contractor, the Contractor shall replace the plant at no cost to the Authority.
 - ii. All questions related to responsibility for the replacement planting will be subject to site inspection and agreement of the appointment of responsibility.
 - iii. This will be done very month at the monthly maintenance inspections.
- Final Handover
 - i. Two weeks before the end of the Maintenance Period a joint inspection shall be held with the Maintenance Agency, Contractor and the Authority/Authority's representative review the requirements for alteration or replacement in order to gain approval for Final Handover.
 - ii. In order to ensure satisfactory handover procedures, the site meetings held each month between the Contractor and Authority/Authority's Representative will be used to inspect and approve the maintenance works which will be reviewed to ensure adequate work has been done.
 - iii. At the time of the final inspection, all areas under this contract shall be free of weeds, neatly cultivated and raked, and all plant boxes in good order.

- iv. Grass shall be neatly cut and all clippings removed. No bare patches of earth shall be visible in turf or planting areas unless specified (that is rings around tree trunks).
- v. If, after this inspection, the Authority/Authority's representative is of the opinion that all work has been performed in accordance with the drawings and specifications, the Authority/Authority's representative will give written letter of acceptance and completion of the project.
- vi. If, all or certain portions of the work are not acceptable under the terms and intent of the drawings and specifications, the formal maintenance period for all the work shall be extended at no cost to the Authority/Authority's representative until the defects in the work have been corrected and the work is accepted by the Authority/Authority's representative.

5B.3 SPECIFICATION FOR FIRE PROTECTION WORKS:

5B.3.1. Equipment & Services To Be Provided By The Contractor

1. This specification covers the general requirements of design, preparation of detailed drawings, supply of material, manufacture, testing, inspection at BIDDER'S works, packing, forwarding, transportation, transit insurance, delivery at site, unloading and handling at site from storage area to workplace, erection / installation, testing, commissioning at site and carrying out performance / acceptance tests of the equipment, warranty certificate as per requirement, materials and services of the complete fire protection system (FPS) for the 400 MLD Chennai Seawater Desalination Plant Project.
2. The scope of work is as listed below;
3. This Package is for provision of Fire Protection System for 400 MLD Chennai Seawater Desalination Plant Project.
4. The fire protection systems in this package consist of the following types:
 - a. Pump room shall be included pumps with Electrical Panel ,controller ,cabling, piping and fitting & ancillary equipment as per technical specifications, system description, schedule of quantities.
 - b. External hydrant system shall be considered for ground floor as per technical specifications, system description, schedule of quantities.
 - c. Sprinkler system & internal hydrant system shall be considered as per technical specifications, system description, schedule of quantities.
 - d. Fire extinguisher shall be supplied by the contractor as free issue material (FIM) and unloading, shifting, storing and positioning of fire extinguishers is the responsibility of contractor. If by any means the extinguishers are depressurised it is contractor's responsibility to get them replenished.
 - e. Fire sealant shall be considered for ground floor & all floors vertical & horizontal penetration. Contractor's scope shall be included making of well & good due to required rebar, binding tar & proper quality frame chequered plate structure.
 - f. First fill of all consumables including grease, lubricants, oil and diesel fuel. Contractor shall also refill all the consumables after successful testing at the time of handing over the system to Employer.

- g. Warpping & coating of underground pipes shall be as per IS 10221 and protection of pipe insulation to be covered with 100mm soft sand. All supports for underground and above ground pipes shall be done by contractor (near buildings).
 - h. Making holes/openings in walls and sealing them back to the satisfaction of Engineer in Charge.
 - i. Automatic pump starting system with all accessories, wiring and connections and pressure switches.
 - j. Pressure gauges 1/2" syphon pipe shall be SS with GI half coupling tapping, isolation valves and piping, bleed and block valves etc complete.
 - k. Diameter 50mm pipe and fittings shall be with threaded fitting and 65 mm dia and above will be grooved fittings.
 - l. All valves above 50mm dia shall be UL/FM approved grooved valve.
 - m. Grooved coupling shall be UL/FM approved.
 - n. Obtaining the approval from CFO & Local fire authority by contractor including submitting the forms, fees, all relevant drawings, interaction with the authorities etc shall be by contractor.
 - o. Test certificates, FM approved documents, Operating & maintenance Manuals of all equipment's / fittings dully signed and certified by bidder.
 - p. Updating and submission of "As Built" drawings
 - q. Any other point not listed above but required for successful completion of the fire protection system should be in the scope of the bidder.
 - r. FM/UL approved breaded type flexible sprinkler pipe shall be provided wherever false ceiling are considered in Architectural drawings.
 - s. All first isolation valve(only at pump suction near to UG tank) next to puddle flange shall be one end flange and other end grooved.
5. The design engineering for this package has been done as per National Building Codes of India (NBC) part IV guidelines 2016, Local Fire Authority requirements; However, as part of design engineering, the following shall be in the scope of bidder:
- a. Preparation of detailed calculation, specific drawings such as general arrangement drawings, fabrication/piping and isometric drawings for hydrant system, sprinkler system, vendor drawings of bought out items, pipe supports drawings, etc.
 - b. Preparation and submission of detailed engineering drawings based on these specifications and latest base drawings / Revit model made available to the successful bidder.
 - c. Preparation and submission of as-built drawings in soft copies and 6 sets hard copies to Employer
 - d. Preparation and submission of one soft and 6 sets hard copies of approved Operation & Maintenance Manual for fire-fighting systems.
 - e. Occupancy certification from local CFO as part of FPS vendor scope.
 - f. Supporting arrangements needed (indoor & outdoor) for the piping, valves and instrumentation, operating platforms / cross-overs etc in pump house
 - g. Valve chambers as necessary shall be include of frame cover heavy duty with cover from FFL.
6. Supply and application of painting shall be as per IS 5 for piping, fitting, valves, equipment, hose cabinets and structural steel and auxiliary steel for supports. The paint should have minimum of 3 years of warranty. In case of failure the contractor should repaint at its own cost.

7. For electrical works please refer relevant specification provided in the tender.
8. For instrumentation please refer relevant specification provided in the tender..
9. Any item which may not have been specifically mentioned herein but are needed to complete the equipment / system shall also be treated as included and the same shall also be furnished and erected, unless otherwise specifically excluded as indicated.
10. Pump inspection shall be arranged for all pumps with performance test. **Important Notes:-** Individual pump testing at factory & Entire pump set performance & sequence of operation testing at factory.
11. The pump should be tested for bench mark at factory and shall be approved by the Local fire Authority.
12. Vibration elimination arrangements of cushy foot mountings (anti-vibration pads) for all pumps sets.
13. All puddle flanges and nozzle for RCC fire water tank will be in scope of GCC contractor.
14. All auxiliary support steel shall be galvanized.
15. Companion flanges, Puddle flanges ,all nuts, bolts shall be galvanized.
16. All kinds of supports as necessary for piping.
17. All anchor bolts, nuts, washers and inserts to be embedded in concrete for the equipment and piping.
18. The flanges, companion flanges with nuts, bolts & gaskets for nozzles on fire water reservoir shall be in the scope of contractor .
19. Fire fighting final flushing/ Hydrotesting to be witnessed by client/consultant & PMC.
20. For routing piping, cabling etc. breaking / making of opening in wall along with re packing or core packing, etc. shall be carried out by Contractor at no extra cost.
21. For pipes of fire water system that enter the buildings, the following will be in scope of contractor:
If the pipe has to cross the retaining wall, then a correct size opening shall be made in the wall and after the pipe is installed, the opening shall be sealed both on inside and outside by using proper sealants as approved by engineer-in-charge (not bitumen). Where pipe has to cross brick / block work wall, then a correct size opening shall be made in the wall, an appropriate sleeve installed and after the fire water pipe is installed, the opening between fire water pipe and sleeve shall be sealed both on inside and outside by using proper sealants as approved by engineer-in-charge.
22. Building Automation System
Fire fighting Contractor shall include the interface to Building Automation System Contractor to provide the interface of Ethernet port with connecting provision of CAT 6 along with Patch card will be readable to BMS.

Important Notes:- All Fire pump electrical panel shall have BMS connectivity with modbus RS485.

Following minimum required points shall transferred to BMS system using soft-integration either BACnet over IP, MODBUS or RS-485.

- Hydrant Jockey pump running
- Hydrant Jockey pump fails to start
- Hydrant Jockey pump trip on overload
- Hydrant Jockey pump in manual mode
- Sprinkler Jockey pump running
- Sprinkler Jockey pump fails to start
- Sprinkler Jockey pump trip on overload
- Sprinkler Jockey pump in manual mode
- Motor driven hydrant main pump running
- Motor driven hydrant main pump in manual mode
- Motor driven hydrant main pump failed to start
- Motor driven sprinkler main pump running
- Motor driven sprinkler main pump in manual mode
- Motor driven sprinkler main pump failed to start
- Motor driven standby pump running
- Motor driven standby pump in manual mode
- Motor driven standby pump failed to start
- Hydrant Engine driven standby pump running
- Hydrant Engine driven standby pump fail to start.
- Hydrant Engine driven standby pump in manual mode
- Diesel fuel tank level low
- Hydrant Engine Driven Pump Battery charge failure
- Sprinkler Engine driven standby pump running
- Sprinkler Engine driven standby pump fail to start.
- Sprinkler Engine driven standby pump in manual mode
- Diesel fuel tank level low
- Diesel fuel tank level low
- Sprinkler Engine Driven Pump Battery charge failure
- Low pressure in discharge header of the system
- Level Switch – High water level
- Level Switch – Low water level
- All isolation valves, wherever provided with supervisory switch (non-padlock valves)
- Spare – 10% of total no's windows

5B.3.2.Equipment & Services To Be Provided By Others

1. The following are the equipment and services that shall be provided to the CONTRACTOR. However details of these requirements shall be specified by the CONTRACTOR within the stipulated time frame.
2. Engineering and construction of all equipment foundations required for this system. For this purpose, CONTRACTOR to provide all required inputs to client in time. Important note: Adequately designed RCC foundations for fire water pump sets with foundation bolt pockets will be provided in the fire water pump house. CONTRACTOR scope includes procurement and grouting of appropriate HILTI bolts (or equivalent make acceptable) based on the actual base frame sizes and pump set loads.

3. Fire doors or walls as barriers.

5B.3.3. Specific Requirements/Instruction To Bidders

1. GP-2 grouting for equipment and Grouting supports, supply of –grouting material such as cement, sand, necessary form work etc. is fire fighting contractor responsibility.
2. No Separate payment will be made for necessary galvanized structural supports of piping.
3. The contractor shall ensure that other utilities/items and aesthetics are not damaged or disturbed due to the installation activities. if contractor is responsible for any mistake or damages other facility, it should be set right by the contractor free of cost to owner.
4. Caps over concealed sprinklers shall be fitted only after painting of ceiling (by others) is completed.
5. Sprinklers shall be masked off prior to painting. Any painted sprinkler or sprinkler coated with plaster of Paris is to be replaced by CONTRACTOR at no cost to client.
6. Method of Testing the System: The following tests shall be carried out for ensuring that the system and various components meet the system specifications and the integrity.
7. Method of Testing System:

Hydrant & Sprinkler piping	<ul style="list-style-type: none"> To withstand min. hydro-test at the pressure 1.5 times the max. working pressure i.e. $12 \times 1.5 = 18 \text{ kg/cm}^2(\text{g})$ for two hours. Leak test: system to be tested at maximum operating pressure for functional test at operating pressure for 24 hours after fixing all components. The grooved end of any pipe should be terminated by suitable coupling and plug enough to withstand the test pressure/system pressure.
Fire water pump	<ul style="list-style-type: none"> Shall be capable of delivering not less than 150 % of rated capacity at a head of not less than 65 % of the rated head
Drain Piping	<ul style="list-style-type: none"> To withstand min. hydro-test at the pressure 1.5 times the max. working pressure i.e., $12 \times 1.5 = 18 \text{ kg/cm}^2(\text{g})$ for two hours.
Cleaning of Piping and Equipment after testing (Flushing)	<ul style="list-style-type: none"> The piping shall be flushed with clear water, intended for fire protection services, after completion of tests. Systems shall be flushed until the outgoing water from the pipes becomes clear.
Wrapper coating on underground pipes	Holiday testing
Other components	As per data sheet / requirements specified.

5B.3.4. Codes And Standards

1. All equipment, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment will be installed. All equipment and systems shall comply in all respects with requirements of codes and standards.
2. Other national standards established to be equivalent or superior to the codes and standards specified are also acceptable. The BIDDER shall furnish English translation of all standards specified in this specification.
3. In the event of any conflict between the codes and standards referred to in the specification and the requirements of this specification, the more stringent of this requirement shall govern.
4. All codes and standards referred to in this specification are latest editions of respective codes and standards.

NBC (Part 4):2016	-	National Building Code (Part 4):2016 – Fire and Life Safety
NFPA	-	NFPA 10, 14, 13, 20, 2001 etc.
IS : 1641-1988	-	Code of Practice for fire safety of building
IS : 9668-1990	-	Provision and Maintenance of water supplies for fire fighting- code of practice.
IS : 12469-1988	-	Specification for Pumps for Fire Fighting
IS : 2190-2010	-	Selection, Installation and Maintenance of First Aid Fire Extinguishers – Code of practise
IS : 2878:2004	-	Specification for fire extinguisher, carbon-dioxide type
IS : 15683:2006	-	Portable fire extinguishers
IS : 6234	-	Portable Fire Extinguishers Water Type (Stored pressure)
IS : 15397	-	Portable Fire Extinguishers Mechanical foam type (stored pressure)
IS : 13849	-	Portable Fire Extinguishers Dry powder type (stored pressure)
IS : 3844-1984	-	Installation and Maintenance of Internal Fire Hydrants and Hose Reels on Premises – Code of practise

IS : 13039-2014	-	External Hydrant Systems Provision. and Maintenance -Code of Practice
IS : 15105-2002	-	Design and Installation of Fixed Automatic Sprinkler Fire Extinguishing Systems – Code of practise
IS : 1239: 2004 (Part-1)	-	Specification for Steel Tubes, Tubular having diameter 150mm or Less
IS : 1239:1992 (Part-2)	-	Specification for Mild Steel Tubular & Other Wrought Steel Pipe Fittings
IS : 8329:2000		Specification for centrifugally cast (spun) ductile iron pressure pipes for Water, gas & Sewage.
IS : 5290:1993		Specification for Landing Valves
IS : 636:1988		Specification for Reinforced Rubber Lined Hose Pipe
IS : 903:1993		Specification for Branch Pipe, Nozzles, Nozzle Spanner and Hose Delivery Coupling
IS : 884:1985		Specification for First Aid Hose Reel for Fire Fighting
IS : 14846:2000		Specification for Sluice Valve for Water Works Purpose (50 – 1200mm Size)
IS : 778:1984		Specification for Copper Alloy Gate Globe & Check Valves for Water Works Purpose
IS : 12469:1988		Specification for Pumps for Fire Fighting System

5B.3.5. Maintenance Requirements

1. In order to carry out preventive maintenance, it should be possible to readily disassemble, repair, and reassemble the equipment system in the shortest period and to attend to any defect by a minimum disassembly.
2. The BIDDER shall furnish one complete set of any special maintenance tools required for normal maintenance of equipment.
3. The BIDDER shall confirm that space shown for the equipment is adequate from point of view of access, easy maintenance and for day to day operation.
4. Bidder to submit operation and maintenance manual, spare list inclusive of critical spare parts, list of service centres for equipments.
5. All system must have convenient maintenance characteristics including :

- a) Minimum disturbance to production during preventive maintenance.
- b) Easy access to replacement part which can be installed by personnel with minimum skill.

5B.3.6. Guarantees And Performance Requirements

1. GENERAL

The fire protection system shall perform satisfactorily to meet the guarantee requirements specified to the entire satisfaction of the client and statutory requirements.

2. NOISE AND VIBRATION

Amplitude of vibration at bearing of rotating equipment shall conform to ISO: 10816-1.

Vibration isolators of proven design shall be furnished by the BIDDER for preventing the transmission of vibration from the equipment (fire water pumps, etc.) to the other neighbouring equipment and structure.

Inertia block with anti vibration pad shall be provided above neoprene-concept drawing required from contractor.

5B.3.7. Painting

- 1. All Paints should have minimum 3 years of warranty, In case of any peeling of paint in between. Contractor shall repaint the same at its own cost.
- 2. Painting in the immediate vicinity of any electrical and rotating equipment and / or pipe in service shall not be performed without the prior written approval of the PURCHASER for the specific structure, equipment, or pipe to be painted.
- 3. The CONTRACTOR's scaffolding shall be erected, maintained and dismantled without damage to structures, machinery, equipment or obstruction to work of other CONTRACTORS.
- 4. All surfaces such as light gauge / glasses, required for clear visual observation shall be cleaned after paint application.
- 5. Special care shall be taken to avoid any paints from dropping on the machined moving parts of equipment, name plates or indicator dials of instruments and control valves. Prior to paint application or spraying paint removable adhesive tape shall be used to cover these.
- 6. On final completion of all work, the CONTRACTOR shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his painting operation and shall remove any paint or other blemishes caused by him on adjacent walls, windows, equipment and finished surface.
- 7. All piping including fittings and coupling shall be painted after hydro test only. wherever required necessary polythene cover to be provided for protection during painting.
- 8. The iron and steel surfaces shall be thoroughly cleaned of all rust, scale, grease or oil by manual or power tools and then primer coat shall be applied.

9. The PURCHASER reserves the right to inspect the cleaning down and painting operations at any stage and if required by PURCHASER/ ENGINEER unsatisfactory surface preparation or paint application shall be emended at CONTRACTOR's expense.
10. On job site, no painting shall be carried out in a dust laden atmosphere or under unsuitable weather conditions viz. when raining or when metal surfaces are damp or when condensation is likely to affect the paint film before it is dry.
11. Surface preparation for underground and aboveground pipe shall be by thorough wire brushing and any additional cleaning as required.
12. All the exposed surfaces of equipment (other than pumps) and piping shall be painted with 1 coat of zinc chromate primer and 2 coats of synthetic enamel paint. Shade of finish paint shall be as per IS:5 PO red colour minimum thickness (DFT) of paint shall be as under:-
 - a. Primer - 1 coat of Etch primer for GI pipe and remaining structure zinc chromate primer with minimum dry film thickness (DFT) 25 microns per coat.
 - b. Finish - 2 coat of synthetic enamel paint with minimum dry film thickness (DFT) 25 microns per coat. Total DFT 50 microns minimum.

5B.3.8. Design Basis Of Fire Protection System

The design of the fire protection system shall be based on the requirements given in Part 4 of National Building Code (NBC 2016) and local fire norms. In case of information not being clear or unavailable, Indian Standard (IS) and NFPA standards shall be followed.

However, the designed system shall be as per discussion with director of fire services in line with local statutory fire norms.

The objective of this concept note is to design a Fire Fighting system that shall provide:

- Life safety of occupants.
- Property protection.
- Compliance with all relevant statutory requirements.
- Minimum disruption during emergency to the operations.

The firefighting system within the buildings shall consist of the following:

- Portable extinguishers provided to fight fire in incipient stage.
- Sprinkler system provided for detection of fires and automatic actuation of fire protection operation in the region of fire, thus preventing its spread across.
- Hydrant system provided to fight fires of higher intensity and as back-up to fire protection operations with portable extinguishers and sprinkler system.

Fire protection system shall be designed to fight single or dual major fire at any given point of time considering the building occupancies and clearances.

General Description of Firefighting system:

- The various buildings are identified as Storage buildings, Business buildings, industrial buildings etc in the project and system shall be designed as centralized or individual based on design factors.
- The buildings shall be automatically sprinklered all building floors, the requirements for same shall be finalized as per NBC 2016 Part 4 table 07 and local fire norms.

- Wet riser cum down comer system and hose reel system in each fire zone/floor, mainly near exit stairs is considered and piping material shall be of GI heavy class "C" pipe with grooved fittings and couplings.
- Portable fire extinguishers (DCP, CO2, AFFF, Water, Wet chemical, clean agent type, etc.) shall be provided as per NBC and IS standards.
- External Hydrants shall be provided outside the periphery of the buildings/plant and the spacing shall be as per design for identified type of hazard.
- Fire monitors and other special systems for particular hazards or occupancies shall be provided, if required as per design.
- Clean agent extinguishing systems (Novec 1230) wherever required by NFPA for particular occupancies within the buildings or plant (such as the large electrical rooms, telecom rooms, server rooms, etc).
- A firefighting water storage tank and fire water pumps (Split case type) comprising electric duty fire pump, diesel stand by fire pump, and jockey pump (vertical inline type) shall be provided and shall be designed as per NBC/IS standards and in line with local code requirements.
- Fire water for the DCP shall be obtained from the Fire water storage tanks which shall be directly obtained from the local Municipal mains. Fire pumps will be used to deliver fire water from the fire water storage tank to the sprinklers and hydrant system.
- The entire firefighting system viz. wet risers and sprinkler system will always be kept under pressure and opening of any hydrant outlet or bursting of any sprinkler will activate the respective pump set through a pressure switch.

5B.3.9. Fire Pumps And Accessories

Scope of work under this section comprises of providing all equipment, appliance, material, labour necessary and required to completely install electrically operated centrifugal pumping sets and a diesel engine driven pump set for Fire Hydrant, Sprinkler Installation as required by the drawings and specified hereinafter or given in the bill of quantities. Without restricting to the generality of the foregoing the pumps and ancillary equipment's shall include the following.

- a. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.
- b. Automatic starting system with all accessories, wiring and connections and pressure switches.
- c. Motor control center.
- d. Annunciation system with all accessories wiring and connections.
- e. Pressure gauges with isolation valves and piping, bleed and block valves.
- f. Suction strainers and accessories.
- g. Vibration eliminator pads and foundation bolts.
- h. Leak-off drain shall be led to the nearest floor drain.

1.1. Main Pump Electrically Driven Pumps

General :

All materials & equipment used shall be IS Approved.

- a. All pumps shall be installed true to level on suitable concrete foundations. Base frames shall rest on vibration isolation mountings as specified, to avoid vibrations.

- b. Pumps and motors /diesel engine shall be truly aligned to the satisfaction of Owner/ Architect/Employer's Representative.
- c. All pump connections shall be of Standard flange type with appropriate number of bolts. Manufacturers' instructions regarding installation, connections and commissioning shall be followed with respect to all pumps, switchgears and other accessories.
- d. Pumps shall be designed for continuous operation and shall have a continuously dropping head characteristic without any zone of instability. Power capacity characteristic shall be no overloading type. Head vs. capacity, input power vs. capacity characteristics, etc., shall match to ensure load sharing and trouble free operation throughout the range. In case of accidental reverse flow through the pump the driver shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed. Contractor under this specification shall assume full responsibility in the operation of the pump and the drive as one unit.
- e. Automatic air release valve shall be provided to vent air from the pump discharge and also to admit to the pump to dissipate the vacuum there, upon stopping of the pump.
- f. Pump coupled with motor or engine on a common base plate shall perform smoothly without any excessive noise or vibration. Also pump shall be provided with re-circulation piping with valves.
- g. All pumps shall have the impeller size chosen to maximum of 80% of the largest size that can be accommodated in the casing.
- h. Pump shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. The shut off head shall not exceed 140% of rated head.

Fire Pump Sets:

- a. Contractor shall provide and install electrically and /or diesel engine operated fire pumps of capacity and head indicated in the drawings/ bill of Quantities.
- b. Pumps shall be horizontal split case multistage meeting the duties as specified in the bill of quantities with C.I. casing, CS diffusers, bronze impeller (hard finished and dynamically balanced) and S.S Shaft with double mechanical seal.
- c. Pumps shall be coupled with motor by means of flexible type coupling. Pumps shall be of type approved by IS /NBC /NFPA and capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head. Shut-off head of pumps shall not exceed 140% of the rated head.
- d. Casing shall be Cast iron to IS 210 Gr. FG 260 and capable of withstanding 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.
- e. Impeller shall be of standard bronze. Impeller shall be secured to the shaft with hydraulically balanced and shall be retained against circumferential movement by keying, pinning or lock rings. All screwed fasteners shall tighten in the direction of normal rotation.
- f. Shaft size shall be selected on the basis of maximum combined shear stress. Shaft shall be of cast steel C-40 and polished to final dimensions and shall be adequately sized to withstand all stresses from motor weight, hydraulic loads, vibrations and torque is coming in during operation. Pump Shaft-Motor Shaft Coupling shall be connected with adequately sized flexible couplings with spacer of suitable approved design. Necessary guards shall be provided for couplings. Pumps shall be with gland plate for gland packing.
- g. Common base plate for mounting both the pump and drive shall be provided. Base plate shall be of rigid construction, shall be fabricated by M.S. channels. Base plate and pump supports shall be so

constructed, the pumping unit shall be mounted so as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.

h. Rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced in the Works. All the components of pumps of identical parameters supplied under these specifications shall be interchangeable.

i. Operational logic mentioned in Section 12.3 to be followed for fire pump room operation. Contractor shall also be responsible for Supply, installation, testing and commissioning the necessary control panel to fulfil the logic mentioned in Section 12.3 along with necessary control cabling and instrumentation.

Electric Motors:

a. Squirrel cage induction motor, TEFC type suitable for operation on 415 volts, 3 phase 50 HZ A.C supply, for the above pump with synchronous speed of 2900 RPM, conforming to IP 55 protection & class F insulation. Rating and design of motors and switchgears shall confirm to the relevant Indian Standard Specification. Motors shall be of continuous rating type and its rating shall be at least equivalent to the horsepower required to drive the pump at 150% of its rated discharge.

b. Power factor of each motor shall not be less than 0.85 lagging under any conditions of load and capacitors of suitable size to raise the inherent power factor to this figure shall be included.

c. Motors shall have IE2 Efficiency ratings.

Motor Starter:

The motor starter shall be as per detail in MCC.

Tests and Inspection (Factory test & Site test):

All pumps to be factory tested before dispatch and following test and inspection shall be offered:

a. Pumps

Witnessed performance test

Witnessed hydrostatic test

Material Test Certificates of impeller, casing, shaft & shaft sleeve.

b. Motors : Routine test

c. Diesel engine

Witness performance test for output, fuel consumption (at full, 75%, 50%, 33% load), jacket water temperature (to & from engine), lube oil temperature (to & from engine), performance at 10% overload for one hour and governor response.

Witnessed performance test shall be for 1 hours at full load and 15 minutes at each part load.

Material test certificates for major components.

1.2. Diesel Engine Driven Pumps

Diesel driven Pump details shall be same as Electrical driven pump indicated in above sr. no 1.1

All materials & equipment used shall be IS Approved.

Scope:

This specification covers the design, manufacture, construction features, erection supervision, and delivery to site, commissioning, and performance testing of diesel engine along with accessories.

Codes & Standards:

The design, manufacture and performance of Diesel engine shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. The equipment shall conform to UL Listed/FM Approved. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. In particular, the equipment shall conform to the latest editions of the standards followed.

Design requirements:

a. Diesel Engine

- The diesel engine shall be single acting, mechanical injection type and shall be furnished with at least the minimum equipment according to standard practice. The power rating, required auxiliaries, guarantees of fuel consumption, parallel operation, governor performance and torsional vibration shall be in accordance with IS Approved.
- The engine shall be provided with an exhaust gas turbocharger having a charge air cooler, integral intake air filter and silencer.
- In the event of complete power failure, cooling water for the jacket water and lube oil heat exchangers will not be available till power is restored by the emergency supply. Diesel engine shall be capable of starting and operating for a few minutes without supply of cooling water. The BIDDER shall indicate the maximum time for which the diesel engine can so operate.

b. Fuel Oil System

- The oil tank shall be provided with a suitable electrical sensing device to signal 'low' oil level in the tank. A mechanical oil level indicator along with measuring scale shall also be provided to indicate low and high levels. This tank shall in particular, conform to the requirements of IS:803 A hand operated / motor operated transfer fuel pump with hoses / piping, 2 nos. isolation valve and NRV and other accessories shall be provided to transfer fuel oil to the tank.
- An AC motor driven intermittent operation fuel oil priming pump if required shall be provided to keep the high pressure system primed with fuel for remote and quick starting at any instant. The pump shall be provided with
- A suitable clock timer for automatic operation at preset time intervals. A suitable pressure relief valve protective device shall also be provided.
- Fuel: The engine fuel oil quality & grade shall be as specified by engine makers. These shall be kept on hand at all times, sufficient fuel to run the engine on full load for six hours, in addition to that in the engine fuel tank.
- Fuel Tank: The fuel tank shall be welded steel constructed to relevant Indian Standard for Mild Steel Drums. The tank shall be mounted above the engine fuel pump to give gravity feed unless otherwise recommended by the manufacturer. The tank shall be fitted with an indicator showing the level of the fuel in the tank. The capacity of the tank shall be sufficient to allow the engine to run on full load for 6 hrs.
- Fuel Feed Pipes: Any valve in the fuel feed pipe between the fuel tank & the engine shall be placed adjacent to the tank and it shall be locked in the open position. Pipe joints shall not be soldered & plastic tubing shall not be used.

- Fuel Tank : Design of the FUEL tank shall be as per NFPA 20, Fuel tank shall have drip tray to contain the fuel in case of any leakage.

Note: There shall be a separate Fuel Tank & Fuel Feed Pipe for each engine.

c. Lube Oil System

- Automatic pressure lubrication shall be provided by engine driven gear type pump. The system should be complete with an oil cooler and 1 x 100 % duplex fine-mesh filters or through 2 x 100% capacity individual filters. Differential pressure gauge across the filters or pressure gauges on either side of the filters shall be provided to monitor the cleanliness of the filters.
- The oil cooler shall be either air or water cooled and shall be equipped with the necessary bypass to bypass the cooler during start up until the oil temperature reaches the pre requisite value.
- Thermostatically controlled heaters shall be provided for heating the lube oil, if ambient conditions warrant the same.
- A DC motor driven standby lube oil pump shall be provided, if specified, to supply lube oil to the engine and turbo-charger on failure of the engine driven oil pump and/or during coasting down period of the engine.
- An AC motor driven intermittent operation pre lube oil pump shall be provided. This pump in conjunction with a suitable clock timer shall supply lube oil intermittently to the engine when the engine is not in operation to keep the system primed with lube oil for remote and quick starting at any instant. A suitable pressure relieve valve protective device shall also be provided.

d. Jacket Water System

- Jacket water system shall be complete with air or water-cooled heat exchangers, thermostatic control with alarm on high jacket water temperature, expansion tank complete with wall brackets. During start up, jacket water shall bypass the heat exchanger until the required temperature is reached. Thermostatically controlled jacket water preheater shall be supplied, if ambient temperature conditions warrant the same.
- For the charge air cooler and lube oil cooler, the cooling water flow to the charge-air cooler shall be thermostatically controlled.

e. Engine Starting System

- Starting of the diesel engine shall be electric starting system as specified in Data Sheet.
- The electric starting system shall comprise of starter motor, starter batteries and battery charger and all the required instruments and accessories. If automatic starting is specified in Data Sheet, facility shall also be provided for manual starting of the engine. Necessary auto/ manual selector switch shall be provided on the diesel engine control panel. Suitable hydrometer shall be provided for testing the specific gravity of the battery electrolyte. A voltmeter should be provided and installed so that the voltage of the batteries may be ascertained.

f. Governing System

- The governor shall be Woodward type or approved equal. The governor characteristics shall comply with the requirements of 'Class A 1-governing' of ISO 3046.
- The governor shall have the following features :
- The governor shall be provided with an electrically operated speeder gear for remote adjustment of generator frequency, suitable for operation on DC voltage indicated in Data Sheet.

- An overspeed trip mechanism shall be provided to automatically shut off fuel in case the set speed reaches about 110% of rated speed. The values at which the mechanism trips the engine shall be adjustable.

- An engine mounted emergency stop push button shall be provided which, when operated will trip the engine.

g. Control System For Diesel Engine

- Unless otherwise specified in Data Sheet, tripping of the diesel set for a normal shut down will be done manually, by means of push buttons. It shall be compatible for interlinking with BMS.

- It should be possible to shut down the diesel engine either through the local push button on the diesel control panel or through the remote push button. The trip impulse should directly go to the engine shut down device without passing through the local/remote selector switch.

- The diesel engine shall be tripped automatically under the following abnormal conditions :

- Overspeed of diesel engine set as sensed by overspeed trip device.

- Low lubricating oil pressure after engine has attained 90% speed.

- Incomplete start after a preset time

- High jacket water temperature

- DC control supply failure

- Emergency stop

- Generator fault

- Any other tripping condition required for the safe operation of the engine.

h. Control Panels

- Suitable control panel comprising of necessary auxiliary relays, Push buttons, DC voltmeters, DC ammeters, DC motor starter, control switches, etc. with complete panel internal wiring shall be provided by the VENDOR. Once the start push button is pressed or starting impulse is given (in the case of automatic starting), complete starting sequence shall be automatically disengage and stop after the engine picks up speed. When the engine stops all the controls shall automatically be reset to its normal starting operation.

- Annunciators shall be supplied by the VENDOR and mounted on each diesel control panel readable to BMS and give visual and audible indication for the following conditions.

- High jacket water temperature and trip

- High lubricating oil temperature

- Low lubricating oil pressure and trip of the engine.

- Fuel oil day tank level low

- Engine overspeed and trip

- Failure to start

- Standby lube oil pump in operation (if provided)

- Lubricating oil priming pump (if provided) in operation

- Fuel oil priming pump(if provided) in operation
- Low DC voltage
- Starting air pressure low (alternatively, if provided)
- DC control supply failure
- Four (4) Nos. spare windows shall be provided
- Each annunciator system shall be provided with :
 - ☐ One push button for acknowledging the audible alarm(visual indication shall persist)
 - ☐ One push button for resetting the visual indication after the fault has been cleared.
 - ☐ One push button for testing the illuminated transparencies.
 - ☐ On the occurrence of a fault the audible alarm shall sound and the appropriate window shall light up. The audible alarm will be silenced by pressing the 'acknowledge' push button. The visual indication shall, however, persist until the relevant fault contact has reset after which the visual indication can be reset by the 'rest' push button.
- After acknowledgement of one trouble by the 'acknowledge' push button, the alarm circuit shall be ready to operate for another fault.
- The VENDOR shall provide all the sensing devices at the diesel engine for the above alarms and accessory relays at the control panel. These shall be suitable for operation on ungrounded DC system. The DC supply will be made available at the control panel by the PURCHASER. Suitable name plates shall be provided for each window.
- i. Power And Control Cables
 - The VENDOR shall include in his scope of supply all auxiliary wiring between the diesel engine and control panels.
 - Dial type thermometers shall be provided as follows :
 - Lube oil outlet temperature from bearing.
 - Lube oil temperature at lube oil cooler inlet/outlet
 - Jacket water temperature at cylinder outlet
 - Jacket water temperature at jacket water heat exchanger outlet
 - Jacket water temperature at the outlet of oil cooler (if applicable)
 - Pressure gauges shall be provided as follows :
 - At the discharge of all auxiliary pumps provided with the diesel engine.
 - At the lube oil cooler outlet
 - At the jacket water inlet to engine
 - Differential pressure gauges across lube oil and fuel oil filters or separate pressure gauges on either side of the filters
 - Pressure switches shall be provided for automatic starting of the DC motor driven standby lube oil pump on low lube oil pressure

- Pressure switches shall be provided for lube oil system to give on alarm if the pressure falls below a pre-set value and subsequently trip the unit when the minimum safe pressure limit has been reached

- A thermostat shall be provided at the lube oil outlet from engine bearing for alarm on high oil temperature.

j. Tachogenerator

- Primary sensing devices, control valves, controller etc. for :

Lube oil temperature and pressure

Engine jacket water temperature

- Leads from all the sensing devices and instruments to which the PURCHASER's cables (from the engine to the diesel control panel) will be connected shall be neatly brought to terminal blocks. The terminal block shall be properly identified.

k. Piping, Valves And Fittings

All necessary interconnecting piping, valves and fittings, supports, filters and strainers shall be provided for lube oil, fuel oil, jacket water, cooling water and starting air systems. Terminal points shall be as per specification. The piping shall be designed, fabricated and tested in accordance with ANSI. B 31.1- Pressure piping code or approved equivalent.

l. Heat Exchanger

- The heat exchangers for cooling lube oil and jacket water shall be either of the following type unless otherwise specified.

- Shell and tube type, conforming to TEMA-C or approved equal.

m. Items of Guaranteed Performance

- The following items of performance shall be guaranteed by the VENDOR in respect of the diesel engine units and the auxiliaries, when operating under the specified site conditions.

Net electrical output at engine shaft

Fuel oil consumption at full load

Lubricating oil consumption at full load

10% overload for one hour without overheating or showing signs of undue stress and within specified frequency variation.

Vibration and noise levels

Governor response, overspeed trip and overspeed capability.

- The VENDOR shall indicate the standards according to which tolerances on the performance figures will be applicable.

n. Shop Tests

- The VENDOR shall perform all the following shop tests to ensure that the equipment conforms to the specifications and meets the performance guarantees.

- Tests on the diesel engine shall include, but not be limited to, the following:

One (1) hour at 50 % load

One (1) hour at 75 % load

Four (4) hours at full load followed by one (1) hour continuous load of 110%.

Specific fuel oil consumption measurement at various loads.

Vibration levels

Noise levels

- The Vendor shall perform hydraulic tests at 1.5 times the design pressure on all pressure parts.
 - Readings shall be recorded at intervals of 15 minutes during the test period of diesel engine. The Vendor shall provide necessary calibrated instruments for the measurement of pressures, temperatures and flow of fuel oil, lubricating oil, jacket water etc, the tests shall be performed in accordance with IS.
 - The VENDOR shall clearly indicate if he is not in a position to carry out any of the above tests.
 - Copies of the test certificates and record of tests shall be submitted to the PURCHASER for approval.
 - In the event, the VENDOR cannot perform any or all of the tests mentioned above or the PURCHASER cannot witness such shop tests if performed by the VENDOR, the VENDOR shall perform all the tests mentioned above at the site subject to PURCHASER'S acceptance after installation and during commissioning.
- o. Painting
- Machined and finished surfaces shall be protected against formation of rust and corrosion by application of suitable rust inhibitors.
 - All steel surfaces which are to be painted shall be thoroughly cleaned, degreased and given one shop coat of primer, prior to assembly.
 - All castings shall be sand blasted, degreased and cleaned before painting.
 - Fire red or PO red colour to be final coat of paint as per site engineer approval.
 - After final testing & inspection the pump shall be connected with couple in diesel engine & proper cover packing to be done.

p. Commissioning

- The VENDOR shall perform the following tests at site, but not limited to the following to the satisfaction of the PURCHASER :

Specific Fuel Oil Consumption test

Lube Oil Consumption test

Vibration

Noise level

Automatic starting up

Governor response

1.3. Diesel engine exhaust pipe

Diesel engine exhaust pipe with necessary thermal insulation with 50 mm. thick glass wool with 1.0mm thick Aluminium sheet cladding, 25mm SS mesh, residential silencer (including all fittings, clamps, galvanized steel support) of suitable dia for the engine.

Size, routing and length of exhaust piping as per the CFO requirement/ approval of pollution Control Board.

1.4. Jockey Pumps (IS approved) with controller

All materials & equipment used shall be IS approved.

a. Contractor shall provide and install jockey pumps of capacity and head indicated in the drawings/ bill of Quantities.

b. Jockey Pumps shall be Inline vertical multistage Centrifugal type.

c. Pumps shall be coupled with motor by means of flexible type coupling. Pumps shall be of type approved by IS /NBC /NFPA and capable of furnishing mentioned pumps flow& the rated head.

d. Casing shall be SS316 and capable of withstanding 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.

e. Impeller shall be of standard SS316. Impeller shall be secured to the shaft with hydraulically balanced and shall be retained against circumferential movement by keying, pinning or lock rings. All screwed fasteners shall tighten in the direction of normal rotation.

f. Shaft size shall be selected on the basis of maximum combined shear stress. Shaft shall be of stainless steel 316 and polished to final dimensions and shall be adequately sized to withstand all stresses from motor weight, hydraulic loads, vibrations and torque is coming in during operation. Pump Shaft-Motor Shaft Coupling shall be connected with adequately sized flexible couplings with spacer of suitable approved design. Necessary guards shall be provided for couplings. Pumps shall be with gland plate for gland packing.

g. Common base plate for mounting both the pump and drive shall be provided. Base plate shall be of rigid construction, shall be fabricated by M.S. channels. Base plate and pump supports shall be so constructed, the pumping unit shall be mounted so as to minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc.

h. Rotating elements shall be so designed to ensure least vibration during start and throughout the operation of the equipment. All rotating components shall be statically and dynamically balanced in the Works. All the components of pumps of identical parameters supplied under these specifications shall be interchangeable.

Electric Motors

a. Squirrel cage induction motor, TEFC type suitable for operation on 415 volts, 3 phase 50 HZ A.C supply, for the above pump with synchronous speed of 2900 RPM, conforming to IP 55 protection & class F insulation. Rating and design of motors and switchgears shall conform to the relevant Indian Standard Specification. Motors shall be of continuous rating type and its rating shall be at least equivalent to the horsepower required to drive the pump at 150% of its rated discharge.

b. Power factor of each motor shall not be less than 0.85 lagging under any conditions of load and capacitors of suitable size to raise the inherent power factor to this figure shall be included.

c. Motors shall have IE2 Efficiency ratings.

1.5. Electric Motor Driven Terrace Pump

Electric Motor Driven Terrace pump should be as per DSR specifications.

5B.3.10. Pipes Work

a. General:

- All pipe work, valves and fittings, unless otherwise specified, shall comply with relevant clauses in the NBC 2016 (Part-IV)/CFO /NFPA regulations
- All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.
- Supply, deliver and install all pipe work materials and fittings for the complete pipe work services installation.
- Pipe work shall follow the routes and positions as per approved and coordinated drawings.
- Pipe work, ancillaries, valves and demountable joints shall be installed for convenient and safe routine maintenance.
- All pipe work shall be installed with adequate gradients to facilitate draining and venting.
- Pipe work shall be run in a neat manner and installed plumb, straight, symmetrical and at right angles to or parallel to adjacent walls.
- No joints shall be formed in wall or floor thickness.
- All pipe work, fittings and valves shall be free from corrosion, scale and internal obstruction.
- Pipe work ends shall be cut square, reamed free from burrs and finished full bore.
- Sufficient unions and flanged joints shall be provided to install and dismantle sections of pipe work, wherever difficulty in dismantling may occur and on straight runs of more than 25m.
- Unions or flanges shall be provided at all valves and equipment for easy dismantling. Connections to coils, pumps, and other equipment shall be made in such a manner as to eliminate undue strains in piping and equipment. Necessary fittings and bends shall be furnished to avoid springing of pipes during assembly.
- Care shall be taken in placing unions to allow freedom to spring apart. Unions and flanges shall not be placed in inaccessible positions. Where pipe work is installed in inaccessible places, a union or flange shall be installed, prior to the pipe passing into the wall or floor. Unions shall have two bronze conical seats ground in. Long screw connections will not be accepted.
- Manufacturer's standard fittings shall be used and fabricated fittings will not be accepted.
- Bends and tees shall be of the easy sweep type, except at air vents, drain points and dead legs where square tees shall be used.
- Changes in diameter of horizontal pipe work shall be formed eccentrically.
- Prior to any work being "covered up", the installer shall request the Engineer's approval to that part of the installation in question. Take appropriate means to prevent galvanic action where dissimilar metals are connected.
- Great care shall be taken during installation of pipes to prevent any sand, earth or other matter from entering the pipe. The pipe shall be kept thoroughly clean during the course of installation. The end of pipes shall be blocked by wooden plugs wedged home, at the end of each day's work to prevent dirt and animals from entering the pipe
- Flanged joints shall be made with 3mm thick compressed synthetic fibre gaskets (non asbestos) gasket. Bolt holes in flanges shall be drilled. The drilling of each flange shall be in accordance with the relevant Indian Standard. Flanged joints shall be used for connections to

vessels, equipment, flanged valves and also on suitable straight lengths of pipeline of strategic points to facilitate erection and subsequent maintenance work.

- Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanized nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable and as shown in standard details to carry the weight of water filled pipe and dead load normally encountered. Hangers and supports shall be thoroughly galvanized after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary.
- Pipe Sleeves shall be provided wherever pipes pass through walls and slab and annular space filled with fibre glass and finished with retainer rings and fire sealant.
- The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe are adequate or as specified / approved by Consultants
- All exposed pipes shall be initially brushed to remove all foreign matter & apply the 2 coats etch primer over the pipe and apply 2 coats of painting in Red P.O. colour/ color as per CFO/engineer approval
- Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.
- All pipes shall be accurately cut to the sizes in accordance with relevant BIS codes and burrs removed before laying.
- Automatic air valves shall be provided at all high points in the piping system for venting.
- Drain valves shall be provided at all low points in the piping system for draining.
- Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.
- Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
- Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work. All pipe work shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.
- All Hydrant, Sprinkler and Water Curtain Pipe Headers and Riser shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" as per site engineer /CFO requirement etc.

Piping & Fittings – GI

a. General

- The pipes shall be galvanized mild steel ERW conforming to the requirements of IS:1239 heavy class "C" up to 150mm dia and conforming to IS:3589 for pipe sizes above 150mm dia minimum 6 mm thick. The Galvanizing shall conform to IS:4736. The Zinc coating shall be uniform, adherent, reasonably smooth and free from imperfections such as flux, ash and drops inclusions, bare patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits and blisters.
- The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the pipe.

- Notes

1. Use flat face flanges and full-face gaskets with cast iron flanged valves.
2. Use flat end covers instead of caps for sizes > 200 mm.
3. Light weight flanges shall be ring type or hub type as per of AWWA C207 (for class d or class e flanges. Is 2062 can also be considered if the vendor guarantees its compliance with the requirements specified in the AWWA C207 std for flange material.
4. For sizes > 150 mm , butterfly valves shall be used in place of gate and globe valves for services other than those covered in note-5.
5. Butterfly valves shall not be used in fire water reservoir outlet and pump suction line.
6. Buried piping shall be coated and wrapped as per tce.m4-134-102 and guidelines of TAC fabricated strainers from is 1239, is 3581 pipes may also be considered if it matches the project requirements.

- c. Jointing

- Screwed (50mm dia pipes and below)

Joint for G.I pipes and fittings shall be made with thread joints and unions . A small amount of red lead may be used for lubrication and prevention. Joints shall not be welded or caulked. Alternatively socket welded joints can be permitted with forged fittings only. Branch reductions upto 2"(DN50) from header piping shall be using, Thread let confirming to ASME B16.11 shall be used.

- Welded (65mm dia and above)

Joints between G.I pipes and G.I fittings shall be made with fitting having "V" groove and welded joints electrical resistance welding in an approved manner. Seamless factory fabricated fittings to be used at the Plantrooms, and ERW at the risers and other locations. All branch off shall be with ERW standard fittings. Fittings ranging from 65mm to 150mm shall be steel tube fittings confirming to IS 1239 Part 2 plain end HEAVY CLASS. Branch reductions above 2"(DN50) through 6"(DN150) & 8 "(DN200) from header piping shall be using, Weldolet confirming to ASME B16.11 shall be used for branch off connection to but welded branch pipes. Branch off for LV and Sprinkler piping from main riser shall be using mechanical Tee fittings.

- Flanged joints (65 mm dia and above).

All flanges shall conform to IS: 6392-2003 Table 17 as applicable. Flanged joint shall be made with 3 mm thick insertion rubber washer/ gaskets, bolts and nuts conforming to IS: 1367 (Galvanized). Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Employer's Representative. For jointing

All types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings. Use matched flange faces and 3mm thick compressed synthetic fiber gaskets (non asbestos) in accordance with IS:6392-1971.

- Unions (up to 50 mm dia):

Approved type of dismountable unions shall be provided on pipe lines of 50 mm dia and smaller dia, in locations similar to those specified for flanges.

d. Pressure Testing

The piping shall be tested in accordance with local fire requirements and NFPA, but in no case shall the system be tested at less than 15kg/sq.cm. Hydrostatic pressure or 1½ times working pressure, if the working pressure is more than 13.8kg/sq.cm the test pressure shall be 3.5kg/sq.cm higher than the working pressure, whichever is greater for 3 hours. All valves shall be kept open during testing

e. Sleeves

- Provide sleeves for each pipe passing through walls, partitions, and floors.
- Sleeve Materials: Sleeve materials shall be 3mm thick galvanized steel.
- Sleeves for Un-insulated Piping: Two pipe sizes larger than pipe passing through sleeve or a minimum of 12mm clearance between inside of sleeve and outside of pipe. Adequate clearance shall be provided to install fire stopping material.
- Sleeve Lengths

Location	Sleeve Length
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Floor	All floor sleeves to extend minimum of 100mm above finished floor level.
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Walls and Partitions	Equal to depth of construction and terminated flush with finished surfaces.
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Sleeves which are contained in walls, ceilings or floors which are fire barriers shall be additionally packed with a non-combustible material for the entire length to form a fire/smoke stop of the required fire rating and sealed with approved fire sealant.

The material shall be subject to approval and must comply with Building Control and the Building Regulations.

The ends of sleeves packed with material which shall have suitable fire resistant mastic applied to seal the fibers and present a neat appearance.

f. Anchor / Thrust block

Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to work hammer and high pressure as per standard installation details.

Thrust blocks shall be provided at all bends, tees, change of direction of pipes both horizontal & vertical and such other location as determined by the Project Manager.

Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Project Manager prior to execution of work.

g. Hangers & Supports

Contractor shall allow for design, fabrication, installation and coordination with other trades for hangers, supporting system and expansion joints for the installed system.

General:

- Design: Design hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to NBC 2016.

- Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

Submittals:

- Contractor shall submit following calculations for hangers and supporting system for Consultant's review, Calculations shall be prepared and sealed by a qualified Structural Engineer and shall show compliance with the loading requirements. Furnish engineering calculations including, but not limited to, the following items.

a) Hanger design criteria

b) Point loadings.

c) Wall and column attachments.

d) Embedment's for supporting for all horizontal and vertical piping.

e) Stresses and forces on mountings and hangers from expansion and contraction of piping.

- Product Data: For each type of product indicated.

- Shop Drawings: Show fabrication and installation details and for the following; include Product Data for components:

a) Trapeze pipe hangers.

b) Metal framing systems.

c) Pipe stands.

d) Equipment supports.

e) Detail fabrication and assembly of trapeze hangers.

f) Design Calculations.

- Welding certificates.

h. Pipe hangers

- Fire protection piping up to DN 50 (2 inch): Adjustable galvanised steel band

- hangars. Above 50mm use adjustable clevis hangers.

- Multiple Hangers for Combination of services: Hot dip galvanised steel, continuous channels cast-in in concrete or suspended from ceiling.

i. Floor supports

- Piping up to DN 150 (6 inch): Adjustable pipe stanchion saddle support complete with U-bolt, stand pipe with adjuster and floor flange, use galvanised steel pipe covering shield for insulated piping.

- Piping over DN 150 (6 inch): Steel pipe roll with steel base and stand. RCC / Structural steel pedestals shall be provided, as appropriate, to locate the base.

j. Vertical piping supports

- Piping up to DN 150 (6 inch): Galvanised steel riser clamps and / or offset pipe clamp.

- Piping over DN 150 (6 inch): Designed and fabricated at site with the following components:
 Gusset plates with integral bearing plates (minimum thickness equal to that of the pipe) welded to pipe.
 Cross channels resting on permanent construction (floor slab / block work); offset to accommodate piping insulation and attached to each other by steel flats welded at both ends
 'Z' cleats welded on the cross channels at the ends of the bearing plates to restrict movement
 Heavy duty vibration isolation pads (50 durometer) placed under
 Bearing plates for vibration / thermal isolation
 Vapour barrier sealed around the gusset plate with mastic sealant

k. Pipe anchors

- Shall be provided in suitable locations to control the direction and effects of movement of the pipe work systems and to resist stresses and loading on pipe work due to forces acting on the pipe work system. Use materials similar or compatible with the pipe work systems. Comply with the requirements of BS EN 13480-3.
- The anchor and guide components shall be of suitable size and design to withstand and transfer the pipeline thrust. They shall be constructed to the general requirements of BS 13480.
- The anchor loads, anchor and guide locations, method of fixing to the structure and design details shall be submitted and reviewed prior to commencement of the works.
- Thrust blocks and suitable anchors shall be provided where pipe work internal pressures are not contained by the jointing system.
- Install guides on each side of axial expansion joints. The first primary guide shall be located within a distance of 4 pipe diameters or 300mm, whichever is the less. The second primary guide shall be located within a distance of 14 pipe diameters from the first guide. Where axial expansion joints are positioned next to an anchor the maximum distance shall be 4 pipe diameters or 300mm, whichever is the less.

l. G. Hanger rods and accessories

- Galvanised steel hanger rods: Galvanized mild steel rods with continuous male thread.
- Turnbuckles: Galvanised, malleable iron castings with female threaded ends, matching with the threaded hanger rods, shall be provided where required. Back nuts shall be provided on both sides of the turnbuckle after adjustment.
- Ball hangers: Manufacturers proprietary products shall be provided for allowing angular movement of the hanger rod, where required
- Threaded rod couplers: Galvanised steel unit machined from bar stock for joining two lengths of threaded hanger rods. Back nuts shall be provided on both sides of the coupler.
- In addition to above all distribution pipes first support shall not be more than 2 meter from the main distribution pipe and last support shall not be more than 450 mm from the end. Similarly, all range pipes first support shall not be more than 2 meter from the main distribution pipe and last support shall not be more than 1.5 m from the end.

m. Painting

- All Paints should have minimum 3 years of warranty, In case of any peeling of paint in between. Contractor shall repaint the same at its own cost.
- Before applying the paints, all surfaces shall be cleaned by copper slag / grid slag or rotary wire brushing and by dry air blast. All surfaces shall be free of all dirt, mud, rust, grease, scale, or other foreign material.
- After copper slag / grid slag or wire brushing is complete, the surfaces shall be protected so that these do not come in contact with grease, oil, other organic matter or moisture prior to application of primer coating.
- Primer coating shall be carried out as quickly as possible after copper slag / grid slag or wire brushing. No copper slag / grid slag or wire-brushed surface shall be allowed to remain un- coated overnight. Any clean surface that subsequently rusts shall be re-blasted or re- wire brushed before the application of primer.
- The iron and steel surfaces shall be thoroughly cleaned of all rust, scale, grease or oil by manual or power tools and then primer coat shall be applied.
- Painting in the immediate vicinity of any electrical and rotating equipment and / or pipe in service shall not be performed without the prior written approval of the PURCHASER for the specific structure, equipment, or pipe to be painted.
- The CONTRACTOR's scaffolding shall be erected, maintained and dismantled without damage to structures, machinery, equipment or obstruction to work of other CONTRACTORS.
- All surfaces such as light gauge / glasses, required for clear visual observation shall be cleaned after paint application.
- Special care shall be taken to avoid any paints from dropping on the machined moving parts of equipment, name plates or indicator dials of instruments and control valves. Prior to paint application or spraying paint removable adhesive tape shall be used to cover these.
- On final completion of all work, the CONTRACTOR shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his painting operation and shall remove any paint or other blemishes caused by him on adjacent walls, windows, equipment and finished surface.
- All piping including fittings and coupling shall be painted after hydro test only. wherever required necessary polythene cover to be provided for protection during painting.
- The PURCHASER reserves the right to inspect the cleaning down and painting operations at any stage and if required by PURCHASER/ ENGINEER unsatisfactory surface preparation or paint application shall be emended at CONTRACTOR's expense.
- On job site, no painting shall be carried out in a dust laden atmosphere or under unsuitable weather conditions viz. when raining or when metal surfaces are damp or when condensation is likely to affect the paint film before it is dry.
- Surface preparation for underground and aboveground pipe shall be by thorough wire brushing and any additional cleaning as required.

- All the exposed surfaces of equipment (other than pumps) and piping shall be painted with 2 coat of Etching type primer and 2 coats of synthetic enamel paint. Shade of finish paint shall be as per IS:5 PO red colour minimum thickness (DFT) of paint shall be as under:-

Primer – 2 coat of Etch primer for GI pipe and remaining structure zinc chromate primer with minimum dry film thickness (DFT) 25 microns per coat.

Finish - 2 coat of synthetic enamel paint with minimum dry film thickness (DFT) 25 microns per coat. Total DFT 50 microns minimum.

- Pipe cleaning and draining

1. All piping shall be thoroughly cleaned of loose scale, dirt, etc., before installation. During the course of the installation, all open ends of pipes shall be plugged or capped to prevent ingress of dirt.

2. After installation and sealing of joints all piping shall be thoroughly cleaned with clean water under pressure to the satisfaction of Engineer. Water samples test may be required if the Engineer is considered as necessary. Water used for this purpose shall be discharged as directed.

3. Any temporary pipe work and equipment necessary for the above cleaning shall be provided by the contractor.

5B.3.11. Valves And Accessories

1. OS&Y Gate Valve Flanged End –

Ductile Iron OS & Y gate Valve Rising Stem, Ductile Iron Body, Flanged End as per ANSI B 16.10 Minimum Class 150, including, bolts/studs, nuts, washers & neoprene gaskets of required thickness

Minimum working pressure shall be 200PSI.

2. Butterfly valve Flanged End –

Ductile Iron Wafer type Gear Operated Butterfly with Tampered Switch, EPDM Encapsulated Disc, Flanged End as per ANSI B 16.10 Minimum Class 150 including necessary nuts, bolts, teflon & gaskets etc complete as per specification and specified inclusive of all accessories required for satisfactory installation.

Minimum working pressure shall be 200PSI.

3. Ball valve-

Brass Ball valve With threaded end, including necessary nuts, bolts, teflon & gaskets etc complete as per specification as specified inclusive of all accessories required for satisfactory installation.

Minimum working pressure shall be 200PSI.

4. Non Return Valve –

Ductile Iron body Swing Check Valve ,Flanged End as per ANSI B 16.10 Minimum Class 150 including necessary nuts, bolts, teflon & gaskets etc complete as per specification and specified inclusive of all accessories required for satisfactory installation.

Minimum working pressure shall be 200PSI.

5. "Y" type Strainer –

Ductile Iron body Y-Type Strainer, Flanged End as per ANSI B 16.10 Minimum Class 150 including necessary nuts, bolts, teflon & gaskets etc complete as per specification and specified inclusive of all accessories required for satisfactory installation.

Minimum working pressure shall be 200PSI.

6. EPDM rubber Expansion joint

Heavy duty floating flange EPDM rubber expansion joint with unit control (tie rod & gusset plate) as per manufacturers specifications of standard length complete with all accessories tested to a pressure not less than 15 Kg/sqcm including rubber gaskets, flanges, nuts, bolts & washers complete required for satisfactory installation.

7. Air Vessel

Contractor shall supply and installed precharged air vessel fabricated from 8 mm thick MS plate(size 450 mm dia & 1500 mm height) for pressurization of hydrant / sprinkler system complete with adequate pressure switches (as per design / requirement) with valves to operate as per operating sequences including 25 mm dia drain valve, air release valve with stop cock on the top, 25 mm dia inlet with isolating valve duly painted from inside and outside with two coats of synthetic enamel paint over a coat of primer complete as required. All air vessels shall be ultrasonic tested & hydrotested by authorised agency and the test certificates shall be provided.

8. INSTRUMENTATION

11.8.1 Pressure Gauge

Sensing Element: Bourdon/ Diaphragm/ Capsule, Casing: SS 316, Movement: SS 304, Glass: Shatterproof, Dial size: 150 mm, Over range Protection: 1.3 times the max. scale reading, Wetted Parts (including accessories): Minimum – SS 316, Accuracy: + 1.0 % of full scale, Up to + 2.0% of full scale for D.P.gauges, External Zero & span adjustment: Required, Accessories: Syphon for services above 75oC, Snubber for pump discharge applications, Chemical diaphragm for corrosive fluid lines, 2-valve manifold for pressure gauge & 3-valve manifold for differential pressure gauge

11.8.2 Pressure Switches

Type: Non-indicating type, Enclosure: Die cast Aluminium with epoxy painting, Wetted Parts (including accessories): Minimum – SS 316, Repeatability: + 1.0 % of full scale reading, Micro switches contacts: 2 Nos. SPDT contacts rated 5A at 240V AC & 2A at 24V DC, Over range protection: 25% above maximum pressure, Process Connection: Bidder to state, Accessories: Syphons for services above 75oC, snubbers for pump discharge applications and chemical diaphragm for corrosive & oil services, 2-valve manifold

11.8.3 Venturi Type Flow Test Meter (FM approved)

FM approved Venturi Type Flow Test Meter with waste cone on Test Line to measure 150% of pump flow and suitable for mounting on 150 mm dia pipe as per specifications.

9. Fire Brigade Inlet Connection (FBIC).

- a) The storage tank shall be provided with a gunmetal 4 way fire water tank inlet connection with 4 Nos 63 mm dia. built - in Non- return valves instantaneous coupling type arranged on 150 mm dia. Pipe with necessary wrapping coating /flanges /nutbolt /gasket and as per spec, butterfly valve and connected to Fire water tank as per specification.

- b) Tag shall be provided on the FBI, indicating the direction of the pipe and its purpose such as "FIRE BRIGADE INLET CONNECTION".

10. Draw Out Connection.

The storage tank shall be provided with two way gunmetal suction collecting head as per IS: 904-1983, hose coupling (draw out connection) with female outlet as per IS 902 complete with 150mm dia. Suction pipe (with necessary wrapping coating /flanges /nutbolt /gasket and as per spec) with one butterfly valve, a foot valve with strainer of approved make complete in all respect. Tag to be added on the post including aluminium chain & PVC cap.

11. Foot valve with strainer

Foot valves shall be Brass(up to 50mm)/ cast iron body(above 50mm), with epoxy coating), brass disc and strainer of approved quality.

Foot valves shall be spring loaded of stainless steel depending on the requirement.

Foot valves seal shall be EPDM.

Valves shall be tested physically for free operation before being mounted or assembled to the pipeline.

5B.3.12. Fire Hydrant System

1. General

- a) Galvanized Iron Class "C" heavy duty pipes fire riser main within the building and as well outside the building.
- b) Landing valves, hose reels, hose cabinets, etc.
- c) All materials shall be of the best quality confirming to these specifications and subject to the approval of the Engineer-in- charge.
- d) Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.,
- e) Pipes and fittings shall be fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceiling and walls.
- f) Valves and other appurtenances shall be so located that they are easily accessible for operations repairs and maintenance.
- g) Joints in risers- All risers shall be installed with grooved couplings with necessary fittings .Horizontal & branch floor piping shall be screwed up to 50mm dia. and grooved joints for higher pipe sizes shall be used.

2. Hydrants Valves

- a) The Hydrants valve confirming to IS 5290 (Type "A") shall have gun metal single outlet having 80 NB flanged inlet. Outlet shall be oblique female instantaneous type coupling having spring loaded lugs; internal parts shall be of copper or gunmetal. ABS plastic cap with chain shall be provided on the outlet of the valve etc.
- b) The hydrant valve shall be ISI marked.

3. Orifice Plates

- a) Contractor shall supply and installed orifice plate flanges on all hydrants having excessive pressure (more than 7 bar complete in all respects), Orifice plates shall be fabricated from 6 mm thick stainless steel plates with plain central hole without burrs.

- b) Orifice plate must have a projecting identification tag.
 - c) The orifice plate shall fitted not less than two pipe internal diameters downstream of the outlet from any elbow or brand.
 - d) The bore of the orifice shall be designed by the Contractor and calculations to be submitted to Owner/ consultant / Employer's Representative for approval.
- 4. Branch pipe and nozzle
 - a) Branch pipes shall be of gun metal with loaded ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring ring to fit into the instantaneous coupling.
 - b) Nozzle shall be of spray type of diameter of 20mm. Nozzle shall be of loaded gun metal branch pipe and nozzle shall be of instantaneous pattern etc.
- 5. Reinforced Rubber-Lined (RRL) fire hose pipe with coupling
 - a) Rubber reinforced lined fire hose pipe (as per IS : 636) type-A of 63 mm dia and 15 meter.
 - b) The Fire Hose Pipe shall be rated for burst pressure of 37.5 kg/sq cm. Hose shall be complete with ISI marked brass male and female coupling (IS:903) bound and riveted to hose pipe with copper rivets and 1.5mm copper wire etc.
 - c) The fire hose as well as coupling shall be ISI marked.
- 6. Hose Cabinet
 - a) Hose cabinet shall be provided for all internal and external fire hydrants.
 - b) Hose cabinets shall be fabricated from SS 304 sheet of fully welded construction with hinged double front door partially glazed (4 mm glass panel) with locking arrangement.
 - c) Weather proof standard size of Fire Hose Cabinet shall be fabricated from 40 x 40 x 5 angle iron sections and 16 gauge MS sheet 750 mm x 600 mm x 250 mm having single or double opening glazed (3.0 mm thick glass) shutter including necessary locking arrangement by allan key, stove enamelled Fire red/PO red finish (as per site engineer approval and local CFO requirement) with " Fire Hose" marked on front, suitable for housing 2 nos. Hose pipe, 1 No. branch pipe . branch pipe with breaking Hammer, One Fire Extinguishers & box key.
- 7. First Aid Hose Reels
 - d) Contractor shall supply and installed swinging type First Aid hose reel in fire red /PO red colour shall be used as per site engineer approval and local CFO requirement
 - e) Hose reel drum thickness of 1.6mm with 30 mts long and 20 mm dia heavy duty rubber water hose, 20 mm dia gate valve stop cock, (IS:778, class - II) terminating with G.M. Coupling & nozzle of 6mm outlet with shut off valve confirming to IS 8090 complete with G.I socket for tap-off, drum and brackets (including painting) for installation on wall with anchor fastner, bolts & nuts conforming to IS:884.
- 8. Fire shaft

- a) Contractor shall supply and installed "J "type hooks supports made of 25 mm dia pipe to support 2 nos. 15 m long hoses and 01 No short branch pipe. Detailed drawing to be made & it must be GI/SS fixable on wall required anchor fastner, nuts, etc complete.

9. Air Release Valve

Contractor shall supply and installed 15 mm Air Release Valve-BRASS for risers, suitable for pressure not less than PN20. inclusive of FM approved ss ball valve and G.I barrel nipple inclusive of all items to complete satisfactory installation ,complete as per data sheet A of Air release valve.

10. Pipes and Fittings

- a) All hydrant pipe headers/riser shall be worded indicating the direction of the flow and its purpose such as "TO RISER NO.1" as per site engineer /CFO requirement etc.
- b) Following pressure rating criteria to be followed while selecting the pipes, fittings ,valve and accessories .

Sr.No.	Description	Pressure Rating
1	Pipes in pump room.	PN 20
2	Riser from ground to terrace floor.	PN 16

5B.3.13. Automation Sprinkler System

1. General

- a) Pipes fittings and support shall be the same as for Fire Hydrant System.
- b) Sprinklers and multiple controls installed in the sprinkler systems shall be suitable for the fire protection service. Sprinklers shall not be reconditioned or repaired. Used and/or defective sprinklers shall be replaced by new ones. However, the multiple control systems may be repaired or reconditioned but pressure testing shall be carried out before commissioning such installations.
- c) The sprinkler heads are of fixed temperature type with a quartzoid bulb containing liquid having high vapour pressure held in position by forged GM yoke and a deflector confirming to IS 15105.
- d) Contractor shall supply and installed 25 spare sprinkler heads and 2 nos. spanners neatly installed in a steel box with glass shutter at an appropriate position approved by the engineer-in-charge.

2. Wet Automatic Alarm Control Valve (Alarm Check Valve) – UL Listed/FM Approved

The sprinkler system shall incorporate one or more installation control valves as per IS:15105 standard & TAC. Alarm valve to be Ductile iron double seated clapper check valve with grooved seat design. The trim shall be with galvanising fittings and brass/bronze valve rated for 17.5 kg/sq.cm or 1.5 times working pressure whichever is greater. Trim shall be variable pressure with retardant chamber. Minimum working pressure to be 17.5 kg/sq.cm . Valve shall be factory hydro tested at 35 kg/Sq.cm. The Alarm check valve shall be suitable for installation under both variable and constant supply pressure conditions.

The sprinkler system shall incorporate one or more installation control valves as per IS:15105 standard & NBC. Alarm valve to be Ductile iron double seated clapper check valve with grooved seat design. The trim shall be with galvanising fittings and brass/bronze valve rated for 1.5 times working pressure. Trim shall be variable pressure with retardant chamber. Minimum working pressure to be 200 psi. Alarm valve to be UL listed, FM approved. The Alarm check valve shall be suitable for installation under both variable and constant supply pressure conditions.

Installation valve assemblies comprising of following:

- Main Alarm check Valve
- Gate/Butterfly valve
- In and out pressure gauges
- Precision retarding chamber
- Supervisory switch, pressure alarm switch, flow switches
- Test connection of adequate size with valve and orifice plate with pressure connections.
- Alarm Water motor gong with necessary piping isolation valve and strainer and drain.
- Angle main drain valve, check valve, ball valves & indirect drain etc
- Restriction assembly.
- Pressure relief trim kit

The installation control valve shall be straight through type suitable for wet pipe sprinkler systems. Valves shall be of Ductile iron with gun metal/bronze internals and suitable for vertical or horizontal installation with flanged ends.

There shall be two pressure gauges, one for the mains side and another for the installation side. Each gauge shall have pressure damping brass piping with gunmetal gauge and valve

A test connection of adequate size as shown on drawings or as approved shall be provided with a shut off gate valve, check valve, flow switch, an orifice plate with pressure connections. The discharge from the test connection outlet shall be let to the nearest sump or drain as shown on drawings or as directed.

The mains water motor and gong shall be of cast gunmetal body and internals. The valve shall have an associated gunmetal gate valve, strainer, retardant chamber, restriction assembly preceding the water motor. The water motor and gong shall be located on the discharge lead as shown in drawings or as directed by consultant.

The system shall include all accessories like flow switches and, pressure switches etc. for satisfactory operation of ICV.

3. Sprinkler (UL/FM approved)

- b) Sprinkler heads shall be of gunmetal quartzoid bulb type containing liquid having high vapor pressure held in position by forged GM yoke and deflector etc complete as per data sheet A of sprinkler.
- c) Contractor shall supply and installed Pendant type sprinkler of 15 NB, Quartzoid bulb type 68 deg.K 80 standard Response, Coverage Area 12 sq.mtr, with adjustable escutcheon plate

in SS 304 as per UL/FM Approved. It should be installed by teflon tape and lock tite solution etc.

- d) Contractor shall supply and installed upright type sprinkler of 15 NB, Quartzoid bulb type 68 deg.K factor 80 standard Response ,Coverage Area 12 sq.mtr, with adjustable escutcheon plate in SS 304 as per UL/FM Approved. It should be installed by teflon tape and lock tite solution etc.
- e) Contractor shall supply and installed Pendant type sprinkler of 15 NB, Quartzoid bulb type 95/143 deg.K 80 standard Response for kitchen area ,Coverage Area 12 sq.mtr , with adjustable escutcheon plate in SS 304 as per UL/FM Approved. It should be installed by teflon tape and lock tite solution etc.
- f) Contractor shall supply and installed extended Coverage Pendant sprinkler of 80 degree Celsius with escutcheon plate etc.

4. Corrugated / Breaded Type Flexible Sprinkler Pipe

Contractor shall supply and installed UL/FM approved corrugated / breaded type SS-304 flexible sprinkler pipe of 1500mm long with droplet for 13 kg/ sq. cm. working pressure with 1inch inner dia of flexible drope with 1/2" threaded inlet with reducer nipple, snap, clamp, T-bar bracket etc. with necessary fitting complete as required.

5. Zone Control Valve -

Zone/Floor Inspection and testing of the sprinkler system shall be done by providing an assembly consisting of butterfly/slucie valves, flow switch, drain valve, union, test valve , gunmetal sight glass, bye-pass line and orifice assembly as per approved drawing. The system shall consists following:

- Butterfly valve (along with supervisory switch as applicable & to be interfaced with fire alarm)
- Orifice plate
- Flow switch (To be inter faced with fire alarm system)
- Pressure gauge with isolation valve
- Test and Drain valve Assembly all above components shall be as per standard details.
Flow Switch specification is below.
- Flow switch shall have a paddle made of flexible and sturdy material of the width to fit within the pipe bore.
- The terminal box shall be mounted over the paddle/ pipe through a connecting socket.
- The Switch shall be potential free in either NO or NC position as required.
- The switch shall be able to trip and make / break contact on the operation of a single sprinkler head.
- The terminal box shall have connections for wiring to the Annunciation Panel.
- The flow switch shall have connections for wiring the seat shall be of S.S to the Annunciation Panel.
- The flow switch shall have IP: 55 protections.

- The flow switches work at a triggering threshold bandwidth (flow rate) of 4 to 10 GPM. Further, it shall have a 'Retard' to compensate for line leakage or intermitted flows.

6. Sprinkler annunciation panel

Sprinkler annunciation panel 230 V AC input, 50 Hz AC supply & 24 VDC output, standby 24 V DC, operating temperature 00C to 400C which shall be of micro processed based with LED indicators, comprising of 7 Zones with Modular PCB board type visual and audible fire and fault alarms and signals, indicators, call individual or call all, Evacuation alarm facility with pulse timer, Power supply unit etc., complete with stove enameled housing, glass door with locking facility as per detailed specification. located in the lobby area as per the drawing. The Annunciation Panel shall be complete with 2 x 12 VDC sealed maintenance free batteries with battery charger & housed in CRCA sheet steel cabinet (3 mm thick), dust & vermin proof(IP 65) with provision for audio-visual indication. The Annunciation Panel shall be provided with Potential free contacts to enable BMS compatibility kept to main power panel interlink of Ethernet port, along with patch card readable to BMS.

7. Armoured FRLS control wires 2C x 1.5 sqmm made of PVC insulated copper conductor, PVC sheathed, confirming to IS 1554 etc., complete as per Instrumentation specification.

8. Armoured FRLS control wires 2C x 2.5 sqmm made of PVC insulated copper conductor, PVC sheathed, confirming to IS 1554 etc., complete as per Instrumentation specification.

9. Air Release Valve

Contractor shall supply and installed 15 mm Air Release Valve-BRASS for risers, suitable for pressure not less than PN20. inclusive of FM approved ss ball valve and G.I barrel nipple inclusive of all items to complete satisfactory installation.

10. Pipes For Drainage:

- a) Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve.
- b) In the case of other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, auxiliary valves of the following sizes shall be provided.
 - 20 mm valves for pipes upto 50mm dia.
 - 25 mm valves for 80mm dia pipe.
 - 50 mm valves for pipes larger than 80mm dia.

11. Pipes and Fittings

- a) All sprinkler pipe headers/riser shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" as per site engineer /CFO requirement etc.
- b) Following pressure rating criteria to be followed while selecting the pipes, fittings ,valve and accessories .

Sr.No.	Description	Pressure Rating
1	Pipes in pump room.	PN 20
2	Riser from ground to terrace floor.	PN 16

5B.3.14. Fire Extinguisher System**1. General Requirements:**

- Fire extinguishers shall be worked out in such a way that the Occupants shall not travel more than 10m and 15m to reach a Fire extinguisher as per IS 2190:2010
- There shall be a Fire extinguisher for every 200 sq.m of floor plate / rooms / Shops of suitable type / size.
- Extinguishers shall be provided at surface car parks, AHU room, Lift machine room, lobby , corridor reception, server room, electrical installations and on the landing of each staircase of all floors etc as per drawings
- Operating instruction shall be pasted on the extinguisher body.
- Portable fire extinguishers shall be BIS approved and valid ISI certificates to be furnished at the time of delivery to site.
- Stand for fire extinguisher
- All Fire Extinguisher shall be IS marked.

a. Hand Held Fire Extinguishers

- Hand fire extinguishers shall be enamel alloy steel cylinder, provided with a trigger or seat type valve-locking pin or a seal and discharge horn.
- Contents of the extinguisher may be carbon dioxide, dry powder, water gas pressure, or foam, depending on fire class and storage location. Contents shall be such that no poisonous fumes or dangerous acids will be produced in any case.
- Size and type of hand fire extinguishers shall be subject to approval by the Local Authority.
- Fire extinguishers shall be bright red finished and provided with labels indicating dates of filling and renewal.

2. Carbon Dioxide (Co2) type Fire Extinguisher

- The Carbon Dioxide Extinguisher shall be as per IS: 2878
- The body shall be constructed of seamless tube conforming to IS: 7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.
- The discharge mechanism shall be through a control valve conforming to IS:3224. The internal siphon tube shall be of copper Aluminium conforming to relevant specifications.
- Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm² and shall be approximately 1.0 meter in length having internal dia of 10 mm.

- The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form.
- The handgrip of Discharge horn shall be insulated with Rubber of appropriate thickness.
- The gas shall be conforming to IS: 307 and shall be stored at about 85 Kg/cm². The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times, the total discharge time (effective) shall be minimum 10 secs, and maximum 25-secs.
- The extinguisher shall fulfil the following test pressures:
Cylinder: 236 Kg/cm²
Control Valve: 125 Kg/cm²
Burst Pressure of Hose: 140 Kg/cm² minimum
- It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking. The Extinguisher including components shall be IS marked.

3. Water Type Extinguisher (Gas Pressure Type)

- The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.
- The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%
- The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body.
- The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.
- The cap shall be of leaded tin bronze, and screwed on the body up to a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring.
- The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it.
- The discharge hose shall be braided nylon, of 10 mm dia. and 600 mm long, with a nozzle of brass fitted at end.
- The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint.
- The paint shall be stove enameled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling.
- The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm².
- It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side.

- The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for at least 60 secs.
- The extinguisher body shall be clearly marked with ISI stamp (IS 940).

4. ABC Type Dry Powder Extinguisher

- The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 90% from any approved manufacturer.
- The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, Part II, shall be 5 Kg +/-2% or 10 Kg +/- 3%.
- The distribution of fire extinguishers to be as per IS 2190 – 1992. It shall be operated upright, with a squeeze grip valve to control discharge.
- The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurized with Dry Nitrogen, as expellant.
- The Nitrogen to be charged at a pressure of 15 Kg/cm². Body shall be of mild steel conforming to relevant IS Standards.
- The neck ring shall be also mild steel and welded to the body. The discharge valve body shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass.
- The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it.
- Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.
- The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm.
- Discharge nozzles shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtr, continuously, at least for 15 seconds.
- The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity.
- It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside.
- The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face.
- The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm² for a minimum period of 2 minutes.
- The pressure gauge shall be imported and suited for the purpose.

5. Mechanical Foam Type Extinguisher

- The construction of body shall be welded and the requirement of thickness of sheet and details of the construction shall be as per IS-2825-1960 code for pressure vessels. CO2 gas cylinder used for propelling foam solution shall have necessary statutory approvals. The extinguisher shall have furnished with all accessories as needed such as filling orifice with removable s.s strainer, s.s drain plug, pressure vacuum vent,(breather valve) pressure reducer , safety valve, level indicator etc.
- The charge shall be of mechanical foam compound as per IS-4989-1974 (part-11
- AFFF) for producing foam for fire Protection system. The fire extinguisher shall be painted ' FIRE RED ' conforming to shade No 536 of IS- 5-1961.Each fire extinguisher shall be clearly marked with necessary information in English.
- Technical Details are below
 Tank capacity-50LTR
 Gas (co2)- 2 kg in gas cylinder with control valve
 Charge-AFFF (4) Foam expansion 6-8 times
 Discharge jet length-8 to 10 mtr
 Hose length-5 mtr
 Tank shall be epoxy coated in side and outside the tank
 Trolly wheel- 300mm dia solid rubber.
 Discharge Nozzle (specially designed self-aspirating branch pipe)- S.S-304.
 Syphon tube-S.S-304.

6. Bucket

- Design as per IS: 2546.
- Floor mounted bucket stand with GI buckets to hand 4 nos. of 13 ltrs buckets sand filled.
- The stand shall be 5'(L) x 3'(H) x 2"(W) made out of 30 x 300 x4mm MS angle frame duly coated with 2 coats of red oxide primer & 2 coats of red finish paint
- Made out of heavy duty G.I. of gauge 18 to 20 SWG
- Handle at the bottom for easy handling while usage
- Bottom of bucket - hemispherical
- Finishing - Painted
 Outside of the Fire Bucket shall be painted with 2 coats of red oxide primer & 2 coats of red finish paint. The word FIRE shall be written outside the bucket in highly visible colour
 The inside of the Fire Bucket shall be painted with primer and white.

5B.3.15. Summary Of Data To Be Furnished Along With Bid

The BIDDER shall ensure the following documentation are prepared and submitted to PURCHASER along with the Bid:

1. DETAILED ENGINEERING DOCUMENTS AFTER LOI

- a) The detailed engineering documents including sprinkler, hydrant piping layout drawings, Fire extinguishers layout, Pumphouse Piping layout drawings etc., Piping design on node point pressure calculation for sprinkler layouts, support drawings, equipment selection basis etc., Motor kW calculation and all details, etc all complete.
- b) Quality Assurance Plan for each equipment & accessories.
- c) Any drawing detailed fabrication drawing which may be necessary for ring bending / fabrication etc.
- d) Any drawing which may be required to be modified / generated to suit the site condition .
- e) General arrangement drawings for hydrants, water monitors, pumps, diesel tank valves & specialties.
- f) Equipment GA drawings, pipe routings and cross-section drawings., equipment detail drawings, dyke enclosure detail drawing, shop drawings foundation, piping supports, data for all equipment in the system in Contractor's scope with loading details.
- g) Quality assurance plan.
- h) Purchase specifications / requisitions for bought out items.
- a) Procedure for installation, maintenance and operation manual for bought out items.
- b) Final documents Occupancy & NOC certificate from CFO authority

2. FINAL DOCUMENTS

- a) Operation and maintenance manuals.
- b) Quality assurance documentation specific for the project.
- c) Final as built documentation folder containing all drawings and technical data sheets for future reference.
- d) Final Documents should also have the below mentioned documents as per below requirement –(6 Set of each)
- e) As built drawings incorporating field modifications, if any.
- f) CONTRACTOR shall mark-up completely and clearly one set of prints of piping drawings of OWNER/TCE with approved modifications/field-runs carried out at site.
- g) Radiographic report along with radiographs
- h) All NDT records
- i) All alignment protocols
- j) Pipeline hydrotest record.
- k) Quality assurance documentation specific for the project.

- 1) Contractor shall also submit a complete set of approved as built drawings together with performance / rating curves / charts of the equipment, maintenance schedule and test certificates wherever applicable.

SR. No.	Requirements
1	Commissioning Report (Commissioning report shall have all key performance indicators of the particular equipment.)
2	Training & SOP
3	No Due Certificate/NO Claim Certificates
4	Warranty Certificate
5	Signed copy of Snag List
6	As Built Drawing Soft copy (CD)
7	As Built Drawing Hard copy (6 Sets)
8	List of critical spares with its quotation
9	Operation and Troubleshooting manual
10	Test Certificates & list of safety interlocks with validation report
11	Project Handover
12	Signed copy of equipment buy-off sheet.

5B.3.16. Schedule Of Inspection/Testing At Site (To Be Witnessed By Pmc/Gc/Client)

1. The schedule of tests indicated below is indicative and not exhaustive. CONTRACTOR to carry out any other tests at site as per directions of CLIENT.

Sl No.	Name of the System/Equipment	Tests to be carried out at site
a.	Pumps	Performance Test
b.	All rotating equipment	Noise level and vibration level measurement
c.	Power consumption	For all equipment
d.	Pump control panel and logic	Operation test

Sl No.	Name of the System/Equipment	Tests to be carried out at site
e.	Piping (Sample)	Hydrostatic leak test, Wrapper coating thickness, Radiography
f.	Fire Hydrant (Sample)	Operation test
g.	Alarm Valve / Installation Control Valve	Operation Test

5B.3.17. Brief Specification Of Major Components

Sl. No.	Name	MOC/Type/Standard
(i)	Motor driven Main pumps	Horizontal Centrifugal Split case type, CI casing-CI, Impeller-Bronze & Shaft-AISI-410
(ii)	Diesel Engine driven standby pumps	Horizontal Centrifugal Split case type, CI casing-CI, Impeller-Bronze & Shaft-AISI-410
(iii)	Jockey pumps	Vertical inline type, CI casing-CI, Impeller-Bronze & Shaft-AISI-410
(iv)	Pipes up to and including 150mm NB (Normally Filled)	IS:1239 Part-1 (Heavy), Black Note: Option of non-metallic pipes (laid underground) may be explored during detailed engineering.
(v)	Pipes of 200mm NB and above (Normally Filled)	IS:3589, Black Note: Option of non-metallic pipes (laid underground) may be explored during detailed engineering.
(vi)	Pipes up to and including 150mm NB (Normally empty)	IS:1239 Part-1 (Heavy), Galvanised Class "B"
(vii)	Pipe Fittings (65 NB & above)	Grooved /Welded UL or FM approved.
(viii)	Pipe Fittings (50 NB & Below)	Threaded, UL or FM approved.
(ix)	Isolation Gate valves	As per IS 778/14846
(x)	Single Headed Hydrant Valves	63mm SS-304 ISI marked oblique pattern conforming to IS: 5290 Type A.*
(xi)	Fire Hoses	63 mm. Reinforced Rubber-lined conforming to IS:636 Type A OR Controlled Percolation type hose pipe as per IS:8423, with SS-304 instantaneous couplings duly bound at either end and.

Sl. No.	Name	MOC/Type/Standard
(xii)	Branch Pipes with Nozzles	63mm SS-304 ISI marked short pattern (other than fog nozzles) conforming to IS: 903.
(xiii)	Hose Cabinets	Fabricated out of 16 SWG CRCA sheet, with 3mm thick glass fronted doors suitable for holding Two nos. fire hoses, one branch pipe with nozzle and one no. nozzle spanner.
(xiv)	Hose Reels	As per IS:884 and to be provided with 36m long x 20mm dia. rubber hose pipe and SS-304 shut-off nozzle.
(xv)	Sprinkler Alarm Valve, Nozzles, Drain-cum-Test valves & Accessories	UL or FM approved
(xvi)	Portable Fire Extinguishers	Conforming to IS :15683

5B.4 SPECIFICATION FOR HVAC WORKS:

5B.4.1. Scope

This specification is intended to cover design, manufacture, supply, transportation, receipt, handling, storage at site, erection, testing and commissioning of the complete air conditioning and ventilation system for the 400 MLD Chennai Seawater Desalination Plant Project.

5B.4.2. Air-Conditioning System

Outdoor Design Conditions: -

The outside design conditions are given below for Chennai city, are based on ASHRAE 2017 Outdoor Design Conditions@ 0.4 % occurrence.

Latitude: 12.994 N

Altitude: 16 M above mean sea level.

Season	Dry Bulb (DB °C)	Wet Bulb (WB °C)
Summer	38.9	25.9
Monsoon	33.0	28.4
Winter	19.5	20.8

Indoor design conditions:

For Office area/ Conference/Meeting rooms:

Dry bulb temperature: 24 ± 2 °C

Relative humidity: $55\% \pm 5\%$

For labs

Dry bulb temperature: $22 \pm 2^\circ\text{C}$

Relative humidity: $55\% \pm 5\%$

For Control rooms/VFD rooms/UPS & Battery rooms/ and Server rooms.

Dry bulb temperature: $21 \pm 2^\circ\text{C}$

Relative humidity: Not exceeding 60%.

The hours of operations will be 12 hours for non-critical areas such as meeting rooms, conference rooms and office spaces.

Critical spaces such as Control rooms, VFD rooms, UPS & Battery rooms, Labs and server rooms shall be considered as continuous operation (24x7).

Building envelope data shall be as per approved architectural layout.

Fresh Air Requirement as per ASHRAE Standard 62.1.

Acceptable Indoor Noise Level:

Ducts, grilles, acoustic lining etc.) will be selected, designed and installed in such a manner that the system shall be free of vibration and disturbing sound. The noise levels in conditioned occupied spaces due to all air conditioning equipment will not exceed as specified in bill of quantities and as listed below.

Item	Max. Noise Level dB (A) @ 1m	Vibration isolators requirement
Ceiling Suspended: AHU/Cabinet Fans	65	Spring type vibration isolator between the fan and casing and in the hanging arrangement
Axial flow fans	65	Spring type vibration isolator in the hanging arrangement
Fan coil unit	45	Spring type vibration isolator in the hanging arrangement
VRF/FCU/HI WALL indoor units	35	

Design Parameters for Air Distribution System will be as below:

Discription	Range
Max. Air flow velocity in ducts for Air-Conditioning, m/sec	7
Max. Air flow velocity in ducts for Ventilation, m/sec	9.0
Max. Friction, cm wg. / 100 m duct length	0.8
Outlet velocity at Grille/ Diffusers, m/sec	2.0 to 2.5

5B.4.3. Ventilation System

The areas to be ventilated and the type of ventilation system to be provided shall be as per Table 2.

AMBIENT AIR VENTILATION (DRY) SYSTEM FOR MISCELLANEOUS AREAS

For Ventilation of miscellaneous areas, the ambient mechanical ventilation system shall be designed to maintain dry bulb temperature not exceeding 3°C above ambient dry bulb temperature or based on number of air-changes/hr as specified in Table 2, whichever results in higher air flow rate shall be provided. The ventilation system capacity calculation for various areas shall be as follows:

All areas as mentioned in table 2, shall be provided with supply system comprising supply air fans or supply air intake louvers and exhaust system comprising wall mounted exhaust fans, depending upon the layout of the building. The type of system is detailed under table 2.

For Battery rooms, air intake is through louvers and exhaust by means of 20G MS Epoxy painted ducted exhaust by exhaust fans shall be provided. Higher exhaust air flow rates compared to supply air flow rate shall be maintained within the battery room to maintain negative pressure. All fans, motors, ducting and grilles shall be acid proof and epoxy painted. The fans, motors shall be of anti-spark construction with flame proof motors. Each battery room shall be provided with 2 nos. exhaust fan each of 100% capacity. The roof of the battery room shall be flat and hydrogen concentration shall be maintained within allowable limits. No supply air ducts shall be run inside battery rooms.

Pressurised ventilation for Switchgear rooms / MCC rooms & cable gallery: Filtered air shall be supplied to Switchgear rooms / MCC rooms through ducting and grilles by means of supply air fan and the air is exhausted through gravity dampers, propeller fans of suitable capacity shall be added if necessary/as required by the owner.

REFERENCE CODES AND STANDARDS

All equipment, system and works covered under this specification shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Also, all equipment shall conform to the latest applicable Indian or other International Standards established to be equivalent or superior to the Codes and Standards specified in the tender. The list of some of the major standards applicable are furnished below

- National Building Code of India (NBC) 2016.
- Energy conservation building code (ECBC 2017)
- ASHRAE Handbooks.
- ANSI/ASHRAE standard 90.1-: Energy standard for buildings except low rise residential buildings.
- ASHRAE standard 55: Thermal comfort.
- Indoor air quality as per ASHRAE 62.1.
- Duct construction standards as per IS 655.
- GI Sheets IS: 277.
- Aluminium Sheets IS: 737
- Piping IS1239 Part I & II, IS 3589.

- Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment as per AHRI 1230.
- IS1391:1992 (Part I & II), for Room Air Conditioners.
- American Society of Mechanical Engineers (ASME). Section VIII Div. 1 (Code for Unfired Pressure Vessels - Design, construction, testing and certification of pressure vessels).
- Bureau of Energy Efficiency.
- ANSI/AHRI 430: Central Station Air Handling Units.
- ANSI/AHRI 440: Performance Rating of Room Fan-Coils.
- AHRI 575: Standard for method of measuring machinery sound within equipment room.
- ASME B31.5: Code for Refrigeration piping.
- Air Filters as per ASHRAE 52.1
- Three-phase induction motors IS: 325
- Safety code for air conditioning, IS: 659
- Safety code for mechanical refrigeration, IS: 660
- Centrifugal Fans IS: 4894
- Pipe & Pipe Fitting IS: 1239 & IS 3589
- Fire Damper UL555 S
- AMCA 210 Laboratory Method of Testing Fans for rating.

5B.4.4.Packaged Air Conditioners

The Package air conditioner (PAC) shall be of single skin construction with pre filter section, cooling coil section and fan section. Each PAC shall comprise of the following:

The cabinet housing including various components of packaged air-conditioner shall be of heavy gauge steel, corrosion resistant, finished with synthetic enamel paint, and thermally and acoustically insulated with resin bonded fibreglass or equivalent material. Suitable drain connection shall be provided for removal of condensate collected inside a tray under cooling coil. The access panels shall be easily removable. The cabinet shall be floor mounted on vibration isolators

Hermetic or semi-hermetic scroll compressor, mounted on vibration isolators or neoprene rubber grommets. The refrigerant shall be R407C refrigerant.

Air-cooled condenser shall be with copper tubes and aluminium fins with low noise fans. Speed of axial fans shall not exceed 960 RPM for fans with impeller diameter above 450 mm and 1440 RPM for fans with impeller diameter 450 mm and less. The impeller shall be statically and dynamically balanced. The air cooled condenser and fan shall be enclosed in corrosion resistant carbon steel casing and shall be suitable for mounting in open space - for example on terrace or in wall or window.

The PAC fan shall be direct or V-belt driven centrifugal type with forward curved impeller. The impeller shall be statically and dynamically balanced.

The cooling coil shall be of direct expansion type with copper tubes and extended aluminium fins for higher heat transmission efficiency. This shall be minimum three (3) rows deep and with minimum three (3) fins per centimetre. The air before it enters the cooling coil shall be filtered by dry and cleanable type filter. The filters shall be of washable non-woven polyester media enclosed by HDPE mesh air pre-filter with 90% efficiency down to 10 microns.

Refrigerant piping and controls

The packaged air conditioners shall be provided with microprocessor-based control panel integral with the unit with required controls for safe and efficient operation of the PAC.

Drain piping from PAC to floor drain

Flexible connection between fan and ducting.

One common set of electrical strip heater package of suitable capacity complete with contact, humidistat, safety thermostat, heater box with insulation etc for monsoon reheat mounted inside the A/c plenum / duct.

5B.4.5. Hi Wall Split Air Conditioners

The Hi Wall Split Unit with R407A/ equivalent refrigerant shall be provided and would be located inside the area to be air conditioned. The refrigerant after picking up the heat load from the air conditioned area is passed on to the condenser which is placed outdoor for heat rejection. The refrigerant after heat rejection is then re circulated to the units and the cycle repeats.

The Hi wall Split Unit would essentially comprise the following:

Indoor unit complete with fans, filters, cooling coils, expansion valves etc.

Outdoor unit complete with outdoor fans, condenser coils etc.

Refrigerant piping between the indoor and outdoor units, insulation for suction line.

Necessary drain piping up to the nearest floor drain for each hi wall split unit with thermal insulation

Complete Electrical Supply system like MCC, cabling, control Wiring, etc. to be provided by bidder.

5B.4.6. Thermal And Acoustic Insulation

The insulation material shall be Aluminium foil faced closed cell nitrile rubber (Class "O") and the thickness of insulation shall be as per following table or identified in the schedule of quantity:

Supply Duct in conditioned space (return above False Ceiling)-		19 mm thick
Return Duct in conditioned space	-	13 mm thick
Supply Duct in exposed / non-conditioned space	-	25 mm thick
Return Duct in exposed / non-conditioned space	-	19 mm thick

The acoustic insulation material shall be open cell nitrile rubber (Class "O") of required thickness. The Inside surface of the first 3.0 meters of supply and return air-conditioning duct from AHU/CSU/ TFA/ FCU on which the acoustic lining is to be provided shall be thoroughly cleaned and rendered free from all dust and grease. The portion of supply air duct which is acoustically (internal) insulated need not be insulated thermally (external).

Good quality adhesive as per manufacturer recommendation should be used for pasting 100% surface area of insulation to the duct surface without leaving any air bubble or sag between two surfaces. The joints shall be paste along the thickness of the insulating material. The longitudinal & radial joints should have overlapping 2" strip of same material with min 3mm thickness.

Refrigerant/ Drainpipe Insulation using closed cell nitrile rubber

The outer surface of the pipes on which the insulation is to be provided shall be thoroughly cleaned and rendered free from all dust and grease.

Good quality adhesive as per manufacturer recommendation should be used for pasting 100% surface area of insulation to the pipe surface without leaving any air bubble or sag between two surfaces. The joints shall be paste along the thickness of the insulating material. The longitudinal & radial joints should have overlapping 2" strip of same material with min 3mm thickness.

The insulation material shall be closed cell nitrile rubber covered with 6-7 mil minimum thickness and 200 gram/sqmt $\pm 10\%$ interwoven glass fabric for UV and mechanical protection and the thickness of insulation shall be provided. All valves, fittings etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

5B.4.7.Fresh Air Unit

One (1) no. Fresh air unit each for per AHU/PAC room supplies fresh air to the AHU/PAC room and shall be located in the AHU/PAC room. Each fresh air unit shall comprise of :

One (1) no. Tube axial fan with motor

Pre filter with HDPE media having 18 G GSS frame. The efficiency of the filters shall be 90% down to 10 microns. Maximum Velocity across pre filter shall be 2.5 m/s.

Fine filter with HDPE media having 18 G GSS frame. The efficiency of the filters shall be 99% down to 5 microns. Maximum Velocity across Fine filter shall be 2.5 m/s.

Fresh air louver, volume control damper and connecting duct.

5B.4.8.Louvers / Wall Cowl With Bird Screen

Louver / wall cowl with bird screen shall be provided for supply air inlet and for exhaust with tube axial fans. The louvers shall consist of parallel metallic blades. For louvers, the minimum projected width of blades in horizontal plane shall be 150mm with the blades inclined at minimum 35 degrees. Design face velocity for louvers is 3 m/s.

Bird screen of minimum 16 G wire mesh is to be provided on the outer face of louvers.

5B.4.9. Centrifugal Fan

The centrifugal fan shall be designed for :

Fan RPM : Not exceeding 1000 RPM

Fan type : Backward curved DIDW

Fan outlet Velocity: Not exceeding 12 m/s.

Each centrifugal fan comprises of :

One (1) no. adequately sized Induction motor suitable for 415 V, 3 phase, 50 Hz supply with drive package comprising of fan pulley and V-belt.

Common base frame with spring type vibration isolators.

Inlet guard, outlet damper and flexible connection between duct and fan

5B.4.10. Axial Fan

The Axial fan shall be designed for :

Fan type: Tube Axial / Propeller.

The impeller shall have blades of an aerofoil design.

The speed of the fans shall be 1500 rpm for impeller diameter 450 mm or less and 1000 rpm for impeller diameter above 450 mm.

Axial fans (propeller) shall be of propeller type, for fans with 5 mm of WC fan static pressure and Tube Axial type for fans with static pressure above 5 mm of WC.

Each Axial fan comprises of fan, fan motor, inlet and outlet cone (for Tube axial), Louvered shutter (exhaust fans), bird screen and supporting arrangement.

5B.4.11. Wind Driven Roof Extractor

The wind driven roof extractor shall be designed for:

Fan type : Tube Axial

The impeller shall have blades of an airfoil design

The speed of the fans shall be 1500 rpm for impeller diameter 450 mm or less and 1000 rpm for impeller diameter above 450 mm.

Hood shall be hinged type.

Each wind driven roof extractor comprises of fan and supporting arrangement.

5B.4.12. Control Philosophy For AC System

The control system will consist of necessary operating and safety controls, pushbuttons, indicating lamps, annunciator for annunciating trip of each auxiliary in AC plant etc.

All auxiliaries mentioned above can be operated from the control panel, in addition each drive shall be provided with local push button station for start & stop, the stop push button shall be lockable.

Each AHU shall be provided by PLC based local control panel which shall be suitably interfaced with main control panel

Control panel shall accept fire alarm signal from fire detection system and shall trip all equipment on fire alarm and shall close fire dampers.

Fire damper controls shall be implemented in AHU local control panel. Fire damper position shall be indicated on LCP with the help of limit switches.

5B.4.13. Material Of Construction

<i>Air Handling Unit:</i>	
<ul style="list-style-type: none"> • <i>AHU casing</i> • <i>Cooling coil</i> • Thickness of panels • <i>Fan casing</i> • <i>Fan shaft</i> 	<ul style="list-style-type: none"> : 0.63 mm thick GSS (Min) : Copper tube and Aluminium fins : 25 mm (PUF) : Galvanized steel : EN 8
<i>Air Distribution system:</i>	
<ul style="list-style-type: none"> • <i>Ducting</i> • <i>Diffuser</i> • <i>Grille</i> • <i>Volume control damper blade & frame</i> • <i>Fire damper blades and frame</i> • <i>Louver Frame</i> • <i>Louver Blade</i> 	<ul style="list-style-type: none"> : GSS Zinc coating 200 gms /sq.m or better : Aluminium powder coated : Aluminium powder coated : 18 G GSS : 16 G GSS : 16 G GSS : 20 G GSS

5B.4.14. Table 1: Areas to be air conditioned and type of AC system to be provided

SL No	Building/Area	Type of AC system	Redundancy
1.	Control Building	Package air conditioners	Numbers working + Numbers standby
2.	Admin Building	Package air conditioners	Numbers working + one standby
3.	Laboratory	Package air conditioners	Numbers working + Numbers standby
4.	VFD Panel Rooms	Package air conditioners	Numbers working + Numbers standby
5.	Office rooms/Work station area	Package air conditioners	Numbers working + one standby
B.	Other areas		
1.	If tonnage is equal to or more than 5TR	Package air conditioners	Numbers working + one standby
2.	If tonnage is less than 5TR	Hi-wall split	Numbers working + one standby
3.	Any area which contain PLC based control equipment or local control panel or control and instrumentation equipment and areas that are not ventilated		
4.	Any other area that needs to be air conditioned as per the requirement of owner.		

5B.4.15. Table 2: Areas to be Ventilated and type of Ventilation system to be provided

SL NO	Building/Area	Ambient Air Temperature(°C)	Type of Ventilation system	Min. ACPH	Filtration efficiency (%)	Supply	Exhaust	Redundancy
1.	Battery rooms	Extreme	Air Conditioned	10 or as required for Hydrogen Dilution	90% down to 10 microns	From AHU through ducting	Exhaust fans	2 X 100%
2.	Switchgear/ Electrical Equipment area	Extreme	Ambient air ventilation system	15	90% down to 10 microns	From supply air fan through ducting	Exhaust fans	Multiplicity
3.	Fire fighting pump house	Extreme	Ambient air ventilation system	15		Louvers /Grills	Exhaust fans	Multiplicity
4.	Process Plant building/	Extreme	Ambient air ventilation system	15		Louvers /Grills	Exhaust fans	Multiplicity
5.	Ware house/Work Shop	Extreme	Ambient air ventilation system	15		Louvers /Grills	Exhaust fans	Multiplicity
6.	Locker rooms, pantry and toilets	Extreme	Ambient air ventilation system	10		Louvers /Grills	Exhaust fans	Multiplicity
7.	Any other areas that are not air conditioned	Extreme	Ambient air ventilation system					

5B.5 SPECIFICATION FOR PLUMBING WORKS:**5B.6.1. Scope**

1. This specification is intended to cover design, manufacture, supply, transportation, receipt, handling, storage at site, erection, testing and commissioning of the complete Plumbing system for the 400 MLD Chennai Seawater Desalination Plant Project.
2. For specifications, mode of measurements and scope of work covered under the respective items for the work included under this contract, following documents shall be referred to in the order of precedence as given below:
 - (a) Description of the items and notes if any given in the Schedule of Quantities.
 - (b) Drawings
 - (c) Specifications.
 - (d) Additional/ Special Conditions of Contract.
 - (e) General Conditions of Contract.
 - (f) Applicable Codes and Standards as specified herein with amendments/ revisions issued till date.

In the event of any discrepancy among the documents referred above, the document in the higher order of precedence shall prevail.

3. In the event of any element of specification not being available in any of the documents mentioned above, the instructions of the Engineer in writing shall be followed by the Contractor.
4. The Work shall be carried out as per the drawings and designs duly signed and stamped by the Engineer-in-Charge. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly, the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer-in-charge in writing.
5. The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilise them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful.
6. The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as per the requirements of the different equipment.
7. Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed, and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.
8. In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage done to the building, furniture and fixtures on account of Contractor's carelessness, like open or burst pipes or failure of fittings during testing and commissioning shall be made good by the Contractor at no additional cost.

5B.6.2. Scaffolding

Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS: 4014 and IS: 3696. An independent tied scaffold (single and double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board. Diagonal braces shall not prevent the material being moved along the scaffold run. The scaffolding shall be suitably packed at the ends to prevent damage to the finished work.

5B.6.3. Protection

- Protection against damage: Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.
- Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.
- During installation of piping, open end of pipe shall be protected with temporary cover to prevent dust or other materials entering it.
- Protection during construction: Decorative surfaces shall be carefully protected during construction by providing a temporary cover.
- Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.
- Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.
- Any disfigurement, discolouration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer as to whether any work either in whole or in part is acceptable or not shall be final and binding on the Contractor.

5B.6.4. Guarantee

The Contractor shall guarantee and undertake to maintain and rectify the various components of the Plumbing work installed by him for successful performance for a period as indicated elsewhere in the tender/ contract document. The Contractor shall indemnify the Engineer for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. The format and text of the Guarantee and the Indemnity Bond shall be given by the Engineer.

5B.6.5. Applicable Codes, Standards And Publications

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the Contractor shall meet the requirements of IS and other Codes/ Publications as given below.

SP: 6 (1)	Structural steel sections.
IS: 325	Three phase induction motors.

IS: 554	Dimensions for pipe threads where pressure tight joints are required on the threads
IS:694	PVC insulated cables for working voltages up to and including 1100 V.
IS: 779	Specification for water meters (domestic type).
IS: 800	Code of Practice for general construction in steel.
IS: 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS: 1172	Code of Basic requirements for water supply drainage and sanitation.
IS: 1367 (Part 1)	Technical supply conditions for threaded steel fasteners: General Requirements.
IS: 1367 (Part 2)	Technical supply conditions for threaded steel fasteners: Tolerances for fasteners – Bolts, screws, studs and nuts – Product Grades A, B and C.
IS: 1554 (Part 1)	PVC insulated (heavy duty) electric cables: For working voltages up to and including 1100 V.
IS: 1554 (Part 2)	PVC insulated (heavy duty) electric cables: For working voltages from 3.3 kV up to and including 11 kV.
IS: 1726	Specification for cast iron man hole covers and frames.
IS: 1742	Code of practice for building drainage.
IS: 2065	Code of practice for water supply in buildings.
IS: 2104	Specification for water meter boxes (domestic type).
IS: 2373	Specification for water meters (bulk type).
IS: 2379	Colour code for identification of pipelines.
IS: 2527	Code of practice for fixing rain water gutters and down pipes for roof drainage.
IS: 2629	Recommended practice for hot dip galvanizing on iron and steel.
IS: 3114	Code of practice for laying of cast iron pipes.
IS: 4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Manholes.
IS: 4127	Code of practice for laying glazed stoneware pipes.
IS: 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.
IS: 4985	Unplasticised PVC pipes for potable water supplies - specification.
IS: 5329	Code of practice for sanitary pipe work above ground for buildings.
IS: 5455	Cast iron steps for manholes.

IS: 6159	Recommended practice for design and fabrication of material prior to galvanising.
IS: 7558	Code of practice for domestic hot water installations.
IS: 8321	Glossary of terms applicable to plumbing work.
IS: 9668	Maintenance of water supplies and fire fighting.
IS: 9842	Preformed fibrous pipe insulation.
IS: 9912	Coal tar-based coating materials and suitable primers for protecting iron and steel pipe lines.
IS: 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
IS: 10234	Recommendations for general pipeline welding.
IS: 10446	Glossary of terms relating to water supply and sanitation.
IS: 11149	Rubber Gaskets.
IS: 11790	Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings.
IS: 12183 (Part 1)	Code of practice for plumbing in multi-storeyed buildings: Water Supply.
IS: 12251	Code of practice for drainage of building basements.
BS: 5572	Code of practice for sanitary pipe work.
BS: 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
BS: 8301	Code of practice for building drainage.
BSEN274	Sanitary tap ware, waste fittings for basins, bidets and baths. General technical specifications.
IS: 458	Specification for precast concrete pipes(with and without reinforcement).
IS:651	Salt glazed stoneware pipes and fittings.
IS: 1239 (Part 1)	Steel tubes, tubulars and other wrought steel fittings: Steel tubes.
IS: 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS: 1538	Cast iron fittings for pressure pipes for water, gas and sewage.
IS: 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fitting sand accessories.
IS: 1879	Malleable cast iron pipe fittings.
IS: 1978	Line pipe.

IS: 1979	High test line pipe.
IS: 2501	Copper tubes for general engineering purposes.
IS: 2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Basic profile and dimensions.
IS: 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Tolerances.
IS: 2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Limits of sizes.
IS: 3468	Pipe nuts.
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS:3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 4346	Specifications for washers for use with fittings for water services.
IS: 4711	Methods for sampling steel pipes, tube and fittings.
IS: 6392	Steel pipe flanges.
IS: 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS: 7181	Specification for horizontally cast-iron double flanged pipes for water, gas and sewage.
IS: 778	Specification for copper alloy gate, globe and check valves for water works purposes.
IS: 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS: 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS: 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size).
IS: 3950	Specification for surface boxes for sluice valves.
IS: 5312 (Part 1)	Specification for swing check type reflux (non-return) valves: Single door pattern.
IS: 5312 (Part 2)	Specification for swing check type reflux (non-return) valves: Multidoor pattern.
IS:12992 (Part 1)	Safety relief valves, spring loaded: Design.
IS: 13095	Butterfly valves for general purposes.
IS: 1700	Specification for drinking fountains.
IS: 2692	Specification for ferrule for water services.

IS: 5961	Specification for cast iron gratings for drainage purposes.
EN Norms	EN Norms for Drainage, water supply and pluvia

5B.6.6. Quality Assurance And Quality Control

- The Work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the Quality Assurance and Quality Control system.
- At the site level the Contractor shall arrange the materials, their stacking/ storage in an appropriate manner to ensure quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies, etc. as directed by the Engineer. The test shall be conducted continuously, and the result of tests maintained. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.
- The Engineer shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.
- The test shall be conducted at the site laboratory that may be established by Engineer or at any other Standard Laboratory selected by Engineer.
- The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer shall have them transported and recover at two times the actual cost from the Contractor's bills.
- Testing charges shall be borne by the Contractor.

Testing may be witnessed by the Contractor or his authorised representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

5B.6.7. Concept Design For Internal Plumbing System

This concept design covers the design philosophy of internal plumbing works for 400 MLD Chennai Seawater Desalination Plant Project.

The design of plumbing system shall be based on National Building Code (NBC) 2016 and relevant IS standards.

A. Sanitary Drainage System (Soil And Waste)

The building Sanitary and waste drainage shall be designed as dual stack system (soil and waste stack separately). Vent vertical stack shall be connected to soil line at each floor to protect water seal of European water closet against siphoning. Each stack will have independent soil and waste vertical stack.

For Ground floor and First/Second floor levels etc, the sanitary drainage from the building shall be discharged by gravity and collected into inspection chambers located at ground level.

For below ground floor levels/Basements, the sanitary drainage shall be directed to sumps provided with sump pumps that shall pump the effluent to the site inspection chambers/manholes network at

ground level. The drainage effluents from Kitchens/pantries/Canteens shall be directed to grease interceptors to intercept their greases before they are directed to the nearby site sewage network.

The minimum diameter of the 110 mm for vertical soil and 75 mm for waste stack will be designed. Diameter will vary as per the design flow and load. The soil stack shall be directly connected to the inspection chamber. The waste stack shall be connected to the inspection chamber through a gully trap. Sewage from inspection chamber shall be connected to sewer network.

Sanitary drainage design shall be based on the fixture unit method in the computation of sewage flows and vent pipe sizes. The National Building Code (NBC) 2016 shall be used in the determination of loads and demands.

The pipes shall be sized and laid at a minimum slope of 1% inside the buildings in order to maintain flow velocities above self-cleansing velocity.

Sanitary drainage piping shall be UPVC SWR type B.

B. Rain Water Roof Drainage System

The rain water shall be collected from the roofs by roof drains/khurras connected to vertical risers that shall discharge the storm water to the site storm water piping and Catch basin network at ground level.

Rain water drainage system for the project shall be designed for peak Rainfall Intensity in Chennai. The pipes, roof drains, gutters, etc. will be sized properly to cater for the expected water run-off.

Rainwater drainage pipes shall be HDPE as per IS 14333.

C. Domestic Water Supply System

The domestic water uses to serve toilets and sanitary usage inside the buildings. It shall be directly obtained from the local Municipal mains which shall be stored in an RCC water storage tank i.e. domestic water tank after overflow from underground fire water tank. Water meter will be installed externally near water tank before inlet of the underground water tank. To fulfil short fall of domestic water demand, bowser water shall be considered.

Domestic water will be transferred to overhead water tanks, through transfer pumps or hydropneumatics system as per design.

Domestic water from overhead water tank will be supplied to water supply ring main inside the buildings and further water distribution to the entire floor via vertical stack/mains by Gravity system. A dedicated water supply line will be provided from ring main to overhead fire water tank on terrace for inlet to fire water tank.

Level sensor-based solenoid valve will be installed at terrace level for automatic operation of water transfer pump set. Electronic sensor-based water level indicator shall be considered in design for water tanks to monitor water level in the tanks.

The sizing of the ring main and vertical piping shall be based on the simultaneous demand of fixture units. Domestic water supply system and pipe sizing will be designed considering sanitary wares and fixture selected and approved by client. The design shall be as per NBC 2016.

Domestic water piping material shall be CPVC SDR11 schedule 40/80.

Pumps shall be vertical inline centrifugal pumps or hydropneumatics system as per design.

D. Hot Water Supply System

Domestic Hot water shall be supplied to kitchen sinks, canteens, pantry sinks etc.

Hot water piping material shall be PPR.

5B.6.8. Sanitary Ware And Other Appliances

Scope Of Work

Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following:

- (a) Sanitary appliances and fixtures for toilets.
- (b) Chromium plated brass fittings.
- (c) Stainless steel sinks.
- (d) Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks, etc.
- (e) Mirrors, hand driers, drinking water fountains, etc.

Whether specifically indicated or not the Contractor shall provide for all appliances and fixtures, all fixing devices, nuts, washers, Teflon tape, sealant, cement, brackets, supports, paints, connectors, Chromium Plated (CP) riser pipes, adopters, bolts, screws, hangers, etc., as required.

All exposed pipes within toilets and near appliances/ fixtures shall be of CP brass or copper unless otherwise specified.

General Requirements

- All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer.
- All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, and drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, washers, screws and required connection pieces.
- Fixing screws shall be half round head CP brass screws, with CP brass washers unless otherwise specified.
- Porcelain sanitary ware shall be glazed vitreous china of first quality free from warps, cracks and glazing defects conforming to IS: 2556. The choice of the colour of the Sanitary ware shall be that of the Engineer and nothing extra shall be payable to the Contractor for fixing of Sanitary ware of any colour.
- CP fittings shall be cast brass CP of the best quality approved by the Engineer.

- If Supply of sanitary appliances, fixtures and fittings are in Owner's scope, Contractor shall ensure that no damages occur to the same during shifting, transportation, installation and successful handing over. If any damage occurs, the same shall be replaced by the Contractor at his own cost.
- All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost.
- All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.
- Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:
 - (a) Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection to absolutely prevent any damage to the appliances until satisfactory handing over. (The original protective wrapping shall be left in position for as long as possible).
 - (b) The appliance shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.
 - (c) The appliance shall be fixed in a manner such that it will facilitate subsequent removal, if necessary.
 - (d) All appliances shall be securely fixed. Manufacturers' brackets and fixing methods shall be used wherever possible. Compatible rust proofed fixings shall be used. Fixing shall be done in a manner that minimises noise transmission.
 - (e) Appliances shall not be bedded (e.g. WC pans and pedestal units) in thick strong mortar that could crack the unit (e.g. a ceramic unit).
 - (f) Pipe connections shall be made with de-mountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports an appliance.
 - (g) Appliances shall be fixed so that water falls to the outlet (e.g. baths).
 - (h) All appliances shall be secured as per the recommendations of manufacturer.
 - (i) Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.
 - (j) Sizes of Sanitary fixtures given in the Specifications are for identification with reference to the catalogues of makes considered. Dimensions of similar models of other makes may vary within +10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

Water Closet

- WC shall be wash down or siphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litres of water, flushed by means of a flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Engineer) 32 mm size CP brass flush valve with regulator valve. Flush pipe/ bend shall be connected to the WC by means of a suitable

rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair, which shall be fixed in a manner as approved by the Engineer.

- Each WC set shall be provided with a solid plastic seat, rubber buffers and CP brass hinges. Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.
- Each WC set shall be provided with a fixed type CP brass ablution jet, complete with CP/ plastic piping, concealed type CP brass angle cock, etc. all of approved make and brand. The nozzle of the ablution jet and its holding down plate shall have smooth and rounded edges and shall not be capable of causing any injury to a user or cleaner.

Pan Connector

- The WC pan connector shall be Flexible, soft and shall be made of single body construction with integral fins, made from EVA (Ethyl Vinyl Acetate). The pan connector must confirm to the BS: 5628: 1984. The pan connector must be supplied with factory fitted spring loaded seal guard.
- The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.
- The pan connectors must be stored away from the direct sunlight and flames. While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush / adaptor shall be used. The connector socket is pushed fully home onto the pan spigot; thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such an easy as to ensure that the seals and fins turn inward to ensure proper sealing.

Urinals

- Urinals shall be lipped type half stall white glazed vitreous china of size as called for in the Schedule of Quantities.
- Half stall urinals shall be provided with 15 mm dia. CP spreader, 32 mm dia. CP domical waste and CP cast brass bottle/ "P" trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Engineer.
- Flushing for urinals shall be by means of no hand operation, PVC or ceramic flushing cistern/ electronic auto flush valve with all internal fittings, mounted on a CI brackets, and painted with two coats of approved paint of approved shade and confirming to IS: 2326.
- Flush pipes shall be PVC pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Schedule of Quantities. These shall be measured and paid for separately.
- PVC waste pipes shall be provided for urinals. Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer. These shall be measured and paid for separately.

Urinal Partitions

- Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.
- Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Engineer.

Wash Basin

- Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.
- Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer.
- Each basin shall be provided with 32 mm dia. CP waste with overflow, pop-up waste or rubber plug, CP angle valve, CP riser pipe with connectors/ adaptors and CP brass chain as specified in the Schedule of Quantities, 32 mm dia. CP brass bottle trap with CP pipe to wall flange.
- Wash basin shall be provided with hot and cold water mixing fitting Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 890 mm from finished floor level or as directed by the Engineer or architect.

Sinks

- Sinks shall be stainless steel Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40 mm dia. CP waste, CP angle valve, CP riser pipe with connectors/ adaptors and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Engineer. Flow Rate = 4.5 to 6 Litres per minute @ 80 PSI
- Supply fittings for sinks shall be deck mounted CP swivel faucets with or without hot and cold water mixing fittings.

Janitor Sink

- Janitor's sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities, provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner's Site Representative.
- The supply fittings for Janitor's sink shall be wall mounted type of suitable size

Mirrors

- Mirrors shall be electro coated, 6.0 mm thick glass of approved make, plane or beveled edge of suitable size.. The image shall be clear and without waviness at all angles of vision.
- Mirrors shall be provided with backing of 12 mm thick marine plywood, fixed with CP brass semi-round headed screws and cup washers or CP brass clamps as specified or instructed by Engineer.

Toilet Paper Holder

- Toilet paper holder shall be white glazed vitreous china of size, shape and type specified or of stainless steel/ powder coated brass.
- Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.
- The latter shall be fixed by means of screws/ capping having finish similar to the toilet paper holder in wall/ timber partitions with rawl plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Engineer through another agency.

Liquid Soap Dispenser

- Liquid Soap dispenser shall be wall/ counter mounted suitable for dispensing liquid soaps, lotions and detergents
- Liquid soap dispenser shall be with CP brass bracket, caps, etc. fixed to wall with CP brass screws, and screwed onto wooden rawl plug. The container shall be of CP brass.

Drinking Water Cooler

- It shall have built-in RO Filtration and UV System.
- Drinking water fountain shall be wall mounting type made of stainless steel The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator.
- The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32 mm or 40 mm cast brass trap.

Hand Drier

- The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.
- The hand drier shall be fully hygienic, rated for continuous repeat use.
- The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.
- The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, ac power supply.

Pillar Cock

Pillar cock shall be of CP brass material table mounted type for cold water inlet of approved quality. Make & model shall be as per client section. Pillar Cock shall be provided with Suitable Approved type of Angle Cock.

Robe Hook

Robe hook shall be chromium plated brass or of stainless steel or powder coated brass of suitable size, shape and type. Robe hook shall be fixed with screws/capping having golden finish in wall/doors with rawl plugs or nylon sleeves and shall include screwing and making good as required or directed by the Engineer in Charge.

Paper Towel Dispenser

Paper towel dispenser shall be wall! counter mounted suitable for dispensing paper towels.

Health Faucet

These shall be of CP / sanitary ware. These shall be fixed by means of stainless steel counter sunk screws to wooden! plastic cleats firmly embedded in the wall.

- 15 mm CP health faucet with 1.2m long flexible tube with end nuts & Hook.
- 1 No 15mm CP brass angular stop cock with wall flange
- Hook with CP brass counter sunk screws.

Toilets for Disabled

- Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by the Owner's Site Representative.
- Stainless steel grab bar of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern! Valve shall be provided with chromium plated long handles.

Measurement And Rates

Sanitary fixtures (Porcelain ware and CP fittings) shall be measured by numbers. Rate for providing and fixing of sanitary fixtures, accessories, shall include all items, and operations stated in the respective specifications and Schedule of Quantities and nothing extra is payable. Rates for all items under specification Clauses above shall be inclusive of cutting holes and chases and making good the same, CP brass screws, nuts, bolts and any other fixing arrangements required and recommended by manufacturers, testing and commissioning etc. complete

Mockup And Trial Assembly

The installation of the sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/ Consultant. The contractor shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and

disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be developed to determine the location of puncture holes, holding devices etc. which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / Interior Designer. The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

Supporting And Fixing Devices

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

Final Installation

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

5B.6.9. Soil, Waste, Vent & Rain Water Pipes

Scope Of Work

Soil, waste, vent and rain water disposal scope shall include Supply, Installation, testing, commissioning and successful handing over to Owner as per the drawings, specifications and Schedule of Quantities.

All soil, waste and storm water disposal for the portion above ground level to the public sewers/STP shall be by gravity. The soil, waste, vent and rain water pipes system shall inter-alia include the following:

- (a) Vertical and horizontal soil, waste, vent and rainwater pipes and fittings, joints, supports, paints and connections to fixtures.
- (b) Connection of all pipes to sewer lines as shown on the drawings
- (c) Floor and urinal traps clean out plugs, inlet fittings and rainwater (roof) outlets.
- (d) Testing of all pipes and fittings in the workshop.

- (e) Testing, commissioning and handing over of all pipe's lines after installation.

General Requirements

- Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for fixing pipes on RCC ceilings and RCC/ masonry walls.
- Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance.
- Long bends shall be used on all main pipelines as far as possible. Use of elbows shall be restricted for short connections.
- Wherever piping is going across the separation/ expansion joints of buildings, piping shall be provided with flexible connectors on both sides of such joints or on single side depending on whether any wall is to be crossed or not.

Cast Iron Pipes & Cast Iron Hubless Pipes And Fittings

- Kitchen waste, fittings and accessories shall be cast iron pipes. All pipes shall be straight and smooth and their inside free from irregular bore, blow holes, crack and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron soil pipes conforming to IS: 3989 or sand cast to IS: 1729. & C.I Hub less pipe shall conform IS 210
- Drip seal PJS-43 shall be used for jointing CI pipes & fittings as per manufacturer's specifications. & Coupling with sealing effected by EPDM rubber gasket is used for jointing purpose

Fittings

- (a) Fittings shall conform to the same Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.
- (b) Fittings shall be of the required degree of curvature with or without access door as detailed in the drawings or as directed.
- (c) Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

Fixing

- (a) All vertical pipes shall be fixed by GI clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).
- (b) Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- (c) Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surfaces.
- (d) GI Pipe sleeve one size higher than pipe diameter shall be provided in wall/ floor, wherever pipe crossing wall/ floor. Annular space between pipe and sleeve shall be filled with glass wool and approved sealant as per manufacturer's recommendations.

Clamps

- (a) Holder bat clamps shall be of standard design fabricated from GI flats 40 x 3 mm thick and 10 to 12 mm dia. GI rod and 6 to 10 mm GI nuts and bolts; clamps shall be painted with two coats of synthetic enamel paint over one coat of zinc primer before fixing. The clamps shall be fixed in cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20 mm nominal size) blocks 100 mm x100 mm x100 mm deep.
- (b) Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40 x 3 mm flat iron "U" type clamps with anchor fasteners of approved design.
- (c) Structural clamps shall be fabricated from GI structural members e.g. rods, angles, channels, flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of zinc primer and two or more coats of synthetic enamel paint to give an even shade.
- (d) Slotted angle/ channel supports on walls shall be provided wherever shown on drawings. Angles/ channels/ bolts shall be of sizes shown on drawings or specified in Schedule of Quantities. Angles/ channels shall be fixed to brick walls with bolts embedded in cement concrete blocks of 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20 mm nominal size) and to RCC walls with suitable anchor fasteners as directed by the Engineer. The spacing of support bolts horizontally shall not exceed 1 m.
- (e) Wherever GI clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, making PCC blocks and making good with cement concrete 1:2:4 mix (1 cement : 2 sand : 4 stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.

Traps**(a) Cast iron "P" siphon traps:**

CI "P" siphon traps shall be cast iron trap of self-cleaning design. The trap and waste pipes shall be set in cement concrete blocks of size 300 mm x 300 mm and of required depth, firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks at no extra cost.

(b) Urinal traps:

Urinal traps shall be cast iron P or S traps with or without vent and set in cement concrete block.

(c) Floor trap inlet

Floor trap shall be CI floor trap as per IS: 3989 & for C.I Hubless pipe IS 15905. Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type CI/ GI inlet hopper without or with one or two or three inlet sockets to receive the waste pipe. Joint between waste and hopper inlet socket shall be lead caulked. Hopper shall be connected to a CI P or S trap with at least 50 mm seal (hopper and traps shall be paid for separately). Floor trap inlet hoppers and the traps shall be set in cement concrete blocks as specified under clause 8.3.6 above without extra charge.

CI Pipe Jointing

Soil, waste, vent, anti-siphon and rain water pipes shall be jointed with drip seal PJS-43. Enough skein of jute rope shall be caulked to leave a minimum space for the drip seal to be applied in.

The following minimum procedures shall be complied with while making the pipe joints:

- (a) Ensure that the pipes are clean internally and not damaged.
- (b) The pipes shall be cut square with sharp tools.
- (c) The cut ends of the pipes shall be filed/ reamed and finished smooth.
- (d) Any deformed ends shall be re-rounded.
- (e) It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.
- (f) The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.
- (g) Each metal pipe spigot shall be centred with three lightly wedged pieces of hardwood or folded lead.
- (h) The jointing surfaces shall be cleaned to remove any coatings or cutting oils, etc.

C.I Hub less pipe

Pipe are joined by coupling with sealing effected by EPDM rubber gasket is used. A Shield is used to protect the sealing Gasket.

Cast Iron LA Pipework For Drainage

- Cast Iron LA pipes and fittings shall conform to IS: 1536 and IS: 1538 respectively. Quality certificates shall be furnished.
- Wherever possible junction from branch pipes shall be made by a “Y” tee.
- Clean out plugs shall be provided on head of each drain and at location indicated on plans or directed by the Engineer. Clean out plugs shall be of size matching the full bore of the pipe. Plugs shall be made out with GI coupling caulked into the socket of the pipe or fittings. The end shall be provided with a brass screwed plug with suitable key for opening.

Cast Iron and Cast Iron LA Pipework Installation**Laying**

(a) All cast iron pipes and fittings shall be jointed with drip seal PJS-43, which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra shall be paid for lead wool joints. Depth of drip seal and weight for joints shall be as per the relevant IS code or recommended by manufacturer, whichever is on higher side.

(b) The spigot of pipe or fittings shall be centred in the adjoining socket by caulking. Enough turns of tarred gaskin shall be given to leave unfilled the required depth of socket for depth of 45 mm when the gaskin has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Drip seal shall then be applied to fill the remainder of the socket. This shall be done in one pour.

(c) For lead wool joints the socket shall be caulked with tarred gaskin, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home, skein by skein, with suitable tools and hammers of not less than 2 kg weight until joint is filled.

(d) Instead of drip seal joints, Rubber ring joints can also be provided. In case of CI pipes of spigot-socket with rubber ring joints as specified in BOQ, the rubber rings shall conform to IS: 5382.

(e) It is recommended to provide rubber ring joints.

Cement Concrete Encasing

(a) Cast iron soil and waste pipes under floor finish in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all around. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars, the details of which shall be furnished by the Engineer of required

height at intervals of 1.8 m. Rate for concrete all around pipes shall be inclusive of pillars, supports, shuttering and centering.

Painting

- (a) Soil, waste, vent, anti-siphonage and rain water pipes in any exposed location in shafts, pipe spaces, etc. shall be painted with one coat of zinc/ red oxide primer and two or more coats of synthetic enamel paint of colour as specified to give an even shade.
- (b) Pipes shall be painted with paint of approved quality and shade in accordance with approved pipe colour code.
- (c) GI waste pipes/ hoppers in chase/ concealed shall be painted with two coats of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint over two coats of etch primer.
- (d) CI soil and waste pipes below ground and those covered in cement concrete shall not be painted.

Cutting and Making Good Holes/ Chases

Pipes shall be fixed and tested as the building work proceeds. Contractor shall provide all necessary holes, cut outs and chases in structural members as the building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:1:2 (1 cement: 1 coarse sand :2 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement :2 coarse sand) as directed by the Engineer-in-Charge and the surface restored as in original condition to the entire satisfaction of the Engineer-in-Charge at no extra cost.

Testing

- (a) Testing shall be done in accordance with IS: 1172 and IS: 5329 except as may be modified herein under.
- (b) Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Engineer.
- (c) Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Engineer. The total head in the stack shall be 4.5 m at the highest point of the section under test. A tolerance of 2 litres/cm of diameter/km of pipeline measured during the last ten minutes of the period of test shall be allowed. The period of test shall be as directed by the Engineer. If any leakage is visible, the defective part of the work shall be cut out and made good. A slight amount of sweating which is uniform may be allowed but excessive sweating from a particular pipe or joint shall be watched and shall be construed to be a defect and shall be made good.
- (d) The Contractor shall test all vent pipes by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections and filling water in all trap seals.

The test shall be conducted under a pressure of 25 mm of water and shall be maintained for 15 minutes. The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Engineer.

(e) A test register shall be maintained, and all entries signed and dated by Contractor and Engineer. A proforma of the proposed test register shall be submitted to the Engineer for approval.

(f) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

UPVC & PVC PIPEWORK

UPVC SWR pipe work shall be provided for above ground soil, waste, vent & rain water pipe work UPVC SWR pipes & fittings shall confirm to IS: 13592 & IS: 14735 respectively. Pipes shall be of Type - B, pressure rating 6kgs/cm². The pipes shall be supplied in nominal lengths of 2, 3, and 4 or 6 meters, tolerance on specified lengths shall be +10mm and - 0mm. Any physical test requirements shall be as per IS13592-1992.

Soil, waste & vent pipes shall be uPVC pipes & fittings. PVC (SWR) class pipes of diameter 75 mm, 110 mm, 160 mm, 200 mm and 300 mm, of Type/Grade B (conforming to IS:4985 and 6 kg / cm²) for use in rain water (unless otherwise specified) and of Type B for soil, waste and ventilation system and conforming to IS 13592: 1992, shall be used. The pipes shall be supplied in nominal lengths of 2, 3, and 4 or 6 meters, tolerance on specified lengths shall be +10mm and - 0mm. Any physical test requirements shall be as per IS 13592-1992.

Handling

Because of their lightweight, there may be a tendency for the UPVC pipes to be thrown often during installation. Reasonable care should be taken in handling and storage to prevent damage to the pipes. The pipes shall be stored as per manufacturer's recommendation. The contractor shall be fully responsible in this case. In no case, pipes should be dragged on the ground. Pipes should be given adequate supports at all times.

Pipe work Installation

UPVC pipes shall be laid under the flooring or hanging below slab or fixed on walls either buried or exposed as the case may be, as shown in the drawings. The minimum thickness of fittings shall be of 3.2 mm. the fittings shall be of injection mould type with solvent cement joint (for exposed piping) or rubber ring joint (for concealed piping). The pipes and fittings shall be capable of withstanding sun's rays. UPVC/PVC pipes laid below slab or suspended from

ceiling shall be supported by GI angle brackets / supports as detailed in the drawings.

a) All vertical pipes shall be fixed by GI or MS clamps truly horizontal.

Branch pipes shall be connected to the stack at the same angle as that of the

fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a vent cowl (terminal guard).

- b) Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- c) Contractor shall provide all sleeves, openings, hangers and anchor fasteners during the construction. Sleeves shall be one size higher than pipe or there should be at least 12 mm gap all around between pipes & sleeves. Wherever pipe passes through fire rated wall, the gap shall be filled with fire rated sealant as directed by engineer. For non- fire rated wall, gap shall be filled with wool & silicon sealant (20 mm depth). Contractor shall provide all necessary information to the building work contractor for making such provisions in the structure as necessary. All damages shall be made good by the Contractor at his own cost to restore the surface.
- d) Door type fittings shall be used in vertical piping installations. Door position of fittings shall be on top of fitting. Access door shall be made easily removable. The access door shall be air and water tight. Single - wye shall be used for horizontal branch connection. Double - wye fittings shall be used in vertical piping branch connection only.

Jointing

UPVC/PVC pipes & fittings shall be joined as per the manufacturer's instructions /recommendations. UPVC/PVC pipes and fittings shall be joined with Solvent Cement and jointing shall be carried out as follows

- a) Cut the spigot end of the pipe square.
- b) All burrs from the internal and external surfaces should be removed.
- c) The spigot should be marked with a pencil line at a distance equivalent to the socket depth. Clean the surface within the marked area.
- d) Apply uniform coat of approved solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.
- e) Insert the pipe end into the socket of the fitting and push it in up to the mark.
- f) The pipe work should be assembled in a manner such that it does not entail making of joints in restricted area.

UPVC/PVC Pipe work Testing

- a) UPVC/PVC pipes and fittings assembled shall be tested in accordance with IS 13592 - 1992. The openings of the pipes shall be sealed for the section to be tested. The water column of 2m and shall be maintained for a maximum of 15 minutes. Contractor with their team shall examine carefully all the joints for leakage.

- b) The Contractor shall test all vent pipes by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections and filling water in all trap seals. The test shall be conducted under a pressure of 25 mm of water and shall be maintained for 15 minutes. The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Engineer-in-Charge.
- c) A test register shall be maintained, and all entries signed and dated by Contractor and Engineer-in-Charge. Pro-forma of the proposed test register shall be submitted to the Engineer-in-Charge for approval.
- d) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.
- e) All systems shall be tested in sections as required to expedite the work for other trades and meet construction schedules and final test on completion.

Waste Pipe From Appliances

- Waste pipe from appliances e.g. washbasins, baths, sinks and urinals, etc. shall be of UPVC confirming IS: 4985
- The internal diameter sizes of outlet branch waste pipes for different fittings shall be as follows:

Wash Basin 40 dia.

Urinals 50 dia.

Sink 50 dia.

Nahani Trap 75 dia., 50 mm seal.

Multi Floor Trap 75 or 100 dia. as required, with 50 mm or 75 mm seal.
- All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps as directed by the Engineer. Spacing for the clamps shall be 3,000 mm for vertical runs and 2,400 mm for horizontal runs.
- Pipes shall be UPVC tubes conforming to IS: 4985 and quality certificates shall be furnished. Pipes shall be provided with all required fittings conforming to IS: 4985 e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs, etc. All UPVC waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter.
- The pipes shall be of class 111, 6 Kg/cm². The pipes shall conform to IS 4985- 2000. Fittings shall be of injection moulded PVC conforming to IS 7834 (Part1) - 1975.

- Pipe sleeves and inserts, etc. through RCC wall of buildings either external or internal or for water tanks shall be of PVC provided with water bar flanged.
- W.C. pan connectors shall suit the requirements as per drawing, with 40 dia. vent horn for connection to the anti-siphonage pipe. Pan connector shall be of C.I. or lead.
- Connection to the sewer or storm water collection sumps to be perfectly water tight
- Rainwater flashing shall be of 150 100 or 230 150 fitted on to the bell mouth of rainwater pipes inlet and then covered with cast iron grating and extension piece.
- All rainwater pipes and fittings shall be soil type variety conforming to I.S. 1729-1964 or equivalent. This shall apply to pipe outside buildings within the building or in separate shafts.
- Bathroom C.P. grating shall be having bolted down design out of heavy cast brass with chromium plating of the best approved standards.
- Cast iron grating shall be flat with perfect edge and of the best quality procurable of the specified width and thickness and in the available length.

Pipe Laying And Fixing

The pipe laying and jointing shall be done in accordance with IS 7634 (Part 3)- 1975. Pipes shall be cut to size and chamfered well. Burr's if any shall be removed. Pipes and fittings shall be jointed using solvent cement or rubber ring joints. The pipes and fittings shall be jointed accurately without any stress to achieve leak proof joints.

Testing

The method which is commonly in use is filling the pipe with water, taking care to evacuate any entrapped air and slowly raising the system to the test pressure at 3Kg/cm². The pressure testing may be followed as follows. The field test pressure to be imposed should be not less than the greatest of the following:

- One and half times of maximum sustained operating pressure.
- One and half times the maximum pipe line static pressure.
- Sum of the maximum sustained operating pressure and the maximum surge pressure.
- Sum of the maximum pipe line static pressure and the maximum surge pressure, subject to a maximum equal to the works test pressure for any pipe fittings incorporated.
- The field test pressure should wherever possible be not less than 2/3rd working pressure and should be applied and maintained for at least four hours. If the visual inspection satisfies that there is no leakage the test can be passed.
- A test register shall be maintained and all entries signed and dated by Contractor

and Engineer-in-Charge. A Performa of the proposed test register shall be submitted to the Engineer-in-Charge for approval.

- All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

Cutting And Making Good Holes / Chases

Pipes shall be fixed and tested as the building work proceeds. Contractor shall provide all necessary holes, cut outs and chases in structural members as the building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:1:2 (1 cement: 1 coarse sand :2 stone aggregate 20mm nominal size) or cement mortar 1:2 (1 cement :2 coarse sand) as directed by the Engineer-in-Charge and the surface restored as in original condition to the entire satisfaction of the Engineer-in-Charge at no extra cost.

Drainage Accessories

a) Floor Trap / Urinal Trap Grating

Floor/ urinal traps grating shall be of stainless steel square / round of size 125 x 125 mm square/round as approved by client & shown in the drawing. Floor trap assembly shall be provided with round stainless steel strainer basket as a cockroach trap. Entire assembly shall be complete with ring, frame, outer cup, inner cup, grating, screws etc. of an approved make.

b) Floor Cleanout

Floor cleanout cover shall be of stainless steel square / round of size

125 x 125 mm square / round as approved by client & shown in the drawing. Floor cleanout assembly shall be complete with ring, outer frame, cover, screws etc. of an approved make.

c) CI Khurra

The khurras shall be straight type or bend type as per the location of outlet. It consists of a rigid CI body with aluminium dome with SS screw, leaf trap with grating, CI sheet 450mmx450mm welded to collar. The khurra should be fixed firmly on to the parapet wall or roof slab with concrete. Due consideration shall be given to the finished level of roof while fixing the same.

d) ACO Multiline Drain Channels

i) For Building Entrance- SITC of Prefab Polymer Concrete Drain V100 Multiline Channels as per EN 1433 having following properties a) Compressive strength -96 N/mm² b) Flexural strength -27N/mm² c) Water absorption - 0.07% d) Manning's roughness- 0.011. The Channels must be 'V'-profile in shape with integrated edge protection made up of Galvanised Steel with boltless drainlock® grating with anti shunt 4 no. provision per length. The Channels must also be pre-sloped 1:200 or same invert / variable depth with 500 or 1000 mm length. With tongue and groove joints for interlocking, integrated lip labyrinth sealing for liquid-tight

connection to ground line with needed accessories like end cap, end cap with outlet etc. Channels to have anchoring features on the outside wall to ensure mechanical bond to the surrounding bedding material and pavement surface. Ductile Iron grating with drainlock having slot width of 12 mm and inlet section $371 \text{ cm}^2 / \text{m}$, with anti-slip protection with TPU snap fit locking for load class D400 certified as per EN 1433. The Channels will have nominal width of 100 mm and invert depth varying between 150-250 mm as per design.

ii) For Pump room- SITC of Prefab Polymer Concrete Drain V100 Multiline Channels as per EN 1433 having following properties a) Compressive strength -96 N/mm² b) Flexural strength -27N/mm² c) Water absorption - 0.07% d) Manning's roughness- 0.011. The Channels must be 'V'-profile in shape with integrated edge protection made up of Galvanised Steel with boltless drainlock®grating with anti shunt 4 no. provision per length. The Channels must also be pre-sloped 1:200 or same invert / variable depth with 500 or 1000 mm length. With tongue and groove joints for interlocking, integrated lip labyrinth sealing for liquid-tight connection to ground line with needed accessories like end cap, end cap with outlet etc. Channels to have anchoring features on the outside wall to ensure mechanical bond to the surrounding bedding material and pavement surface. Composite plastic PP bar grate Microgrip, anthracite black with patented anti-slip surface structure, slip resistance class R13 according to DIN 51130 type Heelguard with slot width 8mm, inlet cross section $284 \text{ cm}^2 / \text{m}$ with TPU snap fit locking and certified for load class B125 as per EN 1433. The Channels will have nominal width of 100 mm and invert depth varying between 150-250 mm as per design.

HDPE Pipework

HDPE shall be used for above ground rain water pipe work as shown in drawing & specified in specification. HDPE pipes shall confirm to IS 14333 PE 80 grade, pressure rating shall be as indicated in schedule of quantities.

General HDPE Material Requirements

- a) The colour of the pipe shall be black.
- b) High Density Polyethylene (HDPE) material used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS: 7328 - 1992. HDPE conforming to designation PEEWA-45-T-012 of IS: 7328 - 1992 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g/10 min.
- c) When tested from a composite sample of minimum three pipes as per IS: 2530 -1963, at 190° C with nominal load of 5 kgf, Melting Flow Rate shall be between 0.4 to 1.1 g/10 min (both inclusive) and also shall not differ by more than 20% of the MFR of the material used in manufacturing pipes declared by the manufacturer.
- d) The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin.
- e) The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in the Table below.

Nominal Diameter (DN)	Outside Diameter (mm) (mm)			Tolerance (mm)	Ovality
63	63.0			0.6	1.5
75	75.0			0.7	1.6
90	90.0			0.9	1.8
110	110.0			1.0	2.2
125	125.0			1.2	2.5
140	140.0			1.3	2.8
160	160.0			1.5	3.2
180	180.0			1.7	3.6
200	200.0			1.8	4.0
225	225.0			2.1	4.5
250	250.0			2.3	5.0
280	280.0			2.6	9.8
315	315.0			2.9	11.1
	355	355.0	3.2	12.5	
	400	400.0	3.6	14.0	
	450	450.0	4.1	15.6	
	500	500.0	4.5	17.5	
	560	560.0	5.0	19.6	
	630	630.0	5.7	22.1	

f) When tested from a composite sample of minimum three pipes, in accordance with IS 2530:1963, the carbon black content shall be within 2.5 (\pm) 0.5% and the dispersion of carbon black shall be satisfactory.

g) Tolerance on outside diameter and maximum ovality:

The values specified for tolerance on outside diameter have been calculated as 0.009 DN, rounded off to the next higher 0.1 mm, subject to minimum of 0.3 mm. No negative tolerances are allowed.

- h) The pressure rating of HDPE pipes specials shall be confirming to IS: 14333 or equivalent international standard with temperature and maximum allowable operating pressure criteria as per IS: 14333.
- i) Each straight length of the pipe shall clearly be marked in inedible ink/ paint (inkjet printing) at every one metre with the following information:
- i) The manufacturer's name and trademark.
 - ii) Designation of the pipe as per the standard specified.
 - iii) Lot number/ Batch number/ year of manufacture.
 - iv) The words "PROJECT NAME".
- j) All HDPE fabricated fittings shall be manufactured from the pipe itself made out of same raw material and dimensions as specified above. Fittings shall be strictly fabricated in factory at pipe manufacturing facility. Necessary certificate to be provided by the manufacturer. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer.
- k) Manufacturer to provide drawings for HDPE fittings and non-HDPE specials.

HDPE Pipe Work Jointing

Pipes shall be joined using butt fusion joint. Manufacturer's recommendation/ instructions shall be strictly followed during pipe jointing procedure.

Rain Water Outlet

- a) Rain water out shall be preferably scupper type drain with cast iron body & cast Aluminium grating with stainless steel screws. Suitable adopter / connector shall be used to match the pipe. Wherever shafts are not available near rain water outlet, dome type rain water outlet shall be installed.
- b) Rain water outlet shall be tested for water leaking, prior to waterproofing treatment. Extreme care shall be taken, while sealing gap between rain water outlet & wall slab.

Clamps

Wherever MS/Gi clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement:2 sand:4stone aggregate 20mm nominal size) as directed by the Engineer-in-Charge.

Angles / Channels

Slotted angles/ channels shall be measured per linear metre of finished length and shall include support bolts and nuts, length embedded in the cement concrete blocks of 1:2:4 (1cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) formed in the masonry walls; nothing extra shall be paid for the cement concrete block and making good the masonry wall, anchor fasteners etc. complete.

Manhole Covers

The Cast iron Manhole Cover and Frame shall conform to IS: 1726 and the grade and types have been specified in the Bill of Quantities. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised checkered design on the top surface to provide an adequate non-slip grip.

The sizes of covers specified shall be taken as the clear internal dimensions of the frame. The internal diameter of the manhole is 600mm.

The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

Steps/Foot Rest/Rungs

Steps shall be provided wherever the depth of the manhole / chamber is more than 1.2 m. Foot rest shall be C.I. rungs weighing 5.3 kg and conforming to

IS 5455-1969 or made up of 20 mm diameter polypropylene foot rest with

M.S. reinforcement square or round bars as specified. These shall be embedded 20 cm deep in 20 X 20 X 10 cm blocks of PCC 1:3:6. The blocks with M.S. or C.I. foot rest placed in its centre shall be cast in site along with masonry.

Footrest shall be placed 300 mm apart vertically and 375 mm horizontally in staggered fashion. First footrest shall be 450 mm below top. Footrest shall be painted with bituminous paint and the portion embedded shall be painted with thick cement slurry before fixing.

Installation Of Soil, Waste & Vent Pipes

All Horizontal pipes running below the slab and along the ceiling shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts.

Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

Before joining, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The remainder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipeline shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Prefabricated Grease Interceptors

- (a) The inlet and outlet piping shall have 2 way cleanout tees installed
- (b) The inlet piping shall enter the receiving chamber 2 ½" above the invert of the outlet piping.
- (c) On the inlet pipe, inside the receiving chamber, a sanitary tee of the same size pipe in the vertical position with the top unplugged shall be provided as a turndown. To provide air circulation and to prevent "air lock", a pipe (nipple) installed in the top tee shall extend 2 inches, but not more than 6 inches, above the interceptor ceiling. A pipe installed in the bottom of the tee shall extend to within 18" of the floor of the interceptor.
- (d) The outlet piping shall be no smaller than the inlet piping, but in no case smaller than 4" ID.
- (e) The outlet piping shall extend to 12" above the floor of the interceptor and shall be made of a non-collapsible material, preferably schedule 40 PVC pipe.
- (f) The outlet piping shall contain a tee installed vertically with a pipe (nipple) installed in the top of the tee to extend 2 inches but not more than 6 inches above the interceptor ceiling.
- (g) All pipe penetrations and connections to the interceptor and the sampling box shall be made with resilient connectors. Openings in the sidewall for pipe shall be precast or cored the opening shall be of a size to allow for lateral or vertical adjustments through 20 degrees.
- (h) Baffles Grease interceptors designed with an internal baffle as the primary means for the effective and proper operation of the grease interceptor, shall have a non-flexing (i.e. concrete, steel, etc.) baffle the full width of the interceptor, sealed to the walls and the floor, and extend from the floor to within 2" but not more than 6 "from the ceiling. The baffle shall have an opening centered from the sidewalls at least equal in diameter size to the inlet piping,

but in no case less than 6" ID. The opening shall be 24 to 30" from the bottom. Slot type openings spanning at least half of the tank width are preferable.

(i) The baffle shall divide the grease interceptor as follows: The influent (inlet) compartment shall be 2/3 of the total liquid capacity with the effluent (outlet) compartment at 1/3 liquid capacity of the interceptor.

(j) Access Openings (Manholes)

(k) Access to grease interceptors shall be provided by a minimum of 1 manhole per interceptor division (baffle chamber) and of 24-inch minimum dimensions terminating 1 inch above finished grade or 2 inches above finished grade when located in natural terrain such as grass or landscape beds with a cast iron frame and cover. One manhole shall be located above the influent (inlet) Tee hatch and the other manhole shall be located above the effluent (outlet) Tee hatch. A minimum of 24" of clear opening above each manhole access shall be maintained to facilitate maintenance, cleaning, pumping, and inspections

(l) Location

(m) Grease Interceptors shall be located so as to be readily accessible for cleaning,

(n) Maintenance and inspections.

(o) Further details shall be shared with Prefab vendor for grease trap.

Grease trap shall be measured by numbers and shall include all items specified above and necessary with all connection & support items for installation, commissioning & fixing.

CI/DI covers, frames and steps shall be included as per schedule of quantities.

Measurement And Rates

General

(a) Rates for all items shall be inclusive of all work and items called for in the specifications given above as applicable for the work under floors, in shafts or at ceiling level at all heights and depths.

(b) All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

(c) All rates are inclusive of shop testing, pre-testing at site and final testing of the installations, materials and commissioning.

Pipes

(a) The unit of measurement shall be linear metre to the nearest centimeter.

(b) All CI/ PP/ HDPE/UPVC/PVC soil, waste, vent, anti-siphon age and rain water pipes shall be measured net, correct to a centimetre, including all fittings along their length after fixing. The length shall be taken along centre line of the pipes and fittings. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to all cases i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level. The quoted rate shall include lead jointing.

(c) All CI/ PP/ HDPE/UPVC/PVC pipes shall be measured in running metre correct to a centimetre for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples, nuts, unions, etc. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish. The diameters shall be nominal diameter of internal bore. In case of fittings of unequal bore, the largest bore shall be considered.

Pipe Encasing/ supports

(a) Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centering, curing, cutting, etc. complete as described in the relevant specifications.

GI Supports

(a) GI Supports rate for pipe work shall be included in the quoted BOQ/ SOQ rate and shall include GI channels/ angles (structural steel members), GI bolts, GI nuts, GI washers, brass screws, SS fasteners, GI threaded rod, GI clamps, GI hangers, primer coating, painting, etc. Length of supports embedded in the cement concrete blocks of 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size) formed in the masonry walls shall not be paid extra. Also nothing shall be paid extra for the cement concrete block and making good the masonry wall, anchor fasteners, etc. complete.

Traps

(a) Unit of measurement shall be the number of pieces. All urinal traps, trap gratings, hoppers, clean out plugs shall be measured by number and shall include all items described in the relevant specifications and Schedule of Quantities. Cockroach traps shall not be measured separately and are deemed to be included in the rate for Traps.

Painting

(a) Painting of pipes shall be measured per running metre for each diameter of pipe and shall be inclusive of all fittings and clamps. No deduction shall be made for fittings.

Excavation for Soil Pipes

(a) No extra payment shall be admissible for excavation, dewatering, back filling, consolidation and disposal of surplus earth for soil and waste pipes.

5B.6.10. Drainage System

Scope of work

Without restricting to the generality of the foregoing, the drainage system shall inter-alia include:

- a) Sewer lines including earthwork for excavation, disposal, backfilling and compaction, pipelines, gully traps, grease traps, inspection chambers, manholes, drop connections and connections to the municipal or existing sewer.
- b) Storm water drainage, earth works for excavation, disposal, backfilling and compaction, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain or connected as indicated by the Engineer-in-Charge.
- c) Testing of all pipe lines and the full system after installation.

General Requirements

- a) All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer-in-Charge. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer-in-Charge.
- b) Drainage lines and open drains shall be laid to the required gradients and profiles.
- c) All drainage work shall be done in accordance with the Local municipal bye-laws. Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent Authority.
- d) Location of all manholes, etc. shall be got confirmed by the Engineer-in-Charge before the actual execution of work at site.
- e) All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical(bimetallic) corrosion.

S.W. Gully Traps

- a) Stoneware gully traps shall conform to IS 651:1992. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the trap shall be free from crazing. They shall give a sharp clear note when struck with light hammer. There shall be no broken blisters.
- b) The size of the gully trap shall be specified along with dimension and shall be installed in a chamber as described hereafter.
- c) It shall be fixed on 15 cm. thick and 70 cm square 1:4:8 cement concrete bedding and the gully outlet shall be jointed similarly to the pvc pipes. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating and the bottom of the chamber shall not be less than 230 mm. In addition to 150mm x 150mm CI grating, the chamber shall have a CI frame cover (300mm x 300 mm). It shall then be placed on top of the brick masonry.

The frame and sealed cover shall weigh not less than 7.3 kg. Where ever necessary, sealed cover shall be replaced with CI grating of same size.

Gully trap- brick masonry chamber

a) After fixing and testing gully and branch drain, a brick masonry chamber shall be constructed in second class brick in cement mortar 1:5 (1 cement: 5 fine sand). The chamber shall be built with a 115mm thick brick work round the gully trap from the top of the bed concrete up to ground level. The bedding shall be a 700 mm square in 1:4:8 cement concrete. The gully outlet shall be joined to PVC pipes. The space between the chamber walls and the trap shall be filled in with cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement: 3 coarse sand) finished with a floating coat of neat cement, the corners and bottom to the chamber shall be rounded off so as to slope towards the grating and form a hopper.

b) C.I. cover with frame 300 x 200 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement: coarse: 4 graded stone aggregate 20 mm normal size) and rendered

smooth. The finished top of cover shall be left about 4 cm. above the adjoining ground level so as to exclude the surface water from entering the gully traps.

5B.6.11. Water Supply System

11.1 SCOPE OF WORK

The scope shall include supply, installation, testing, commissioning and satisfactory handing over of the complete water supply system to Owner as per specifications. The water supply system shall inter-alia include the following:

- (a) Distribution system from main supply or overhead tank to all fixtures and appliances for cold and hot water.
- (b) Insulation for hot water pipes.
- (c) Pipe protection and painting.
- (d) Control valves, masonry chambers and other appurtenances.
- (e) Connections to all plumbing fixtures, tanks, appliances and municipal mains.
- (f) Inserts, nozzles for Reinforced Concrete tanks.

The term water supply is used as indicative of all water supply work required and necessary for the building including such external work as may be necessary to make the system functional.

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

- a. Domestic and Flushing water supply.

The contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the owner.

GENERAL REQUIREMENTS

If necessary and if approved by the Engineer, where unavoidable, bends may be formed by means of a hydraulic pipe bending machine for pipes up to 20 mm dia. No bending shall be done for pipes of 25 mm dia. and above. After bending zinc rich paint shall be applied wherever the zinc coating is damaged.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs. Valves shall be located at a height not exceeding 1.6 m above their operating floor/ platform level. Where such a provision is not possible and the valve is to be frequently operated a MS chain shall be provided for its operation.

GI PIPES, FITTINGS AND VALVES

All pipes inside the buildings and where specified, outside the building shall

be M.S. galvanized steel tubes conforming to IS: 1239 of Class specified.

When Class is not specified they shall be Heavy Class. All embedded /
concealed pipes shall be of heavy duty.

Fittings shall be of malleable cast iron galvanized, of approved make. Each

fitting shall have manufacturer's trade mark stamped on it. Fittings for GI

pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes

etc. Fittings etc. shall conform to IS: 1879.

Pipes and fittings shall be jointed with screwed joints using Teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively. GI pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings. All pipe joints after testing of the line shall be seal welded and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

Bib cocks and stop cocks

All bib cocks and stop cocks shall be of C.P. brass conforming to IS: 781 of tested quality and approved make and design, of diameter as specified in schedule of quantities.

Clamps

GI pipes in shafts and other locations shall be supported by GI clamps of design approved by the Engineer-in-Charge. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from MS structural's as described in Clause 6.3.5. Pipes in shafts shall be supported on slotted angles/ channels as specified/ as directed.

Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock or check valve and on straight runs as necessary at appropriate locations as required for easy dismantling and/ or as directed by the Engineer-in-Charge.

10.3.7 Flanges

Flanged connections shall be provided on pipes as required for maintenance/ ease in dismantling or where shown on the drawings, all equipment connections as necessary and required or as directed by the Engineer-in-Charge. Connections shall be made by the correct number and size of the GI nuts/ bolts as per relevant IS Standards and made with 3mm thick insertion rubber washer/gasket. Where hot water or steam connections are made insertion

gasket shall be of suitable high temperature grade and quality approved by the Engineer-in-Charge. Bolt hole dia for flanges shall conform to match the specification for CI sluice valve as per IS: 780. Gaskets shall conform to IS: 11149.

10.3.8 Trenches

All GI/PVC/HDPE pipes below ground shall be laid in trenches with a minimum cover of 600mm. The width and depth of the trenches shall be as follows except at places where welding/ jointing etc. needs larger width of trench. Additional width/ depth shall be provided as necessary for welding/ jointing etc. at no additional cost:

Diameter of pipe	Width of trench	Depth of trench
15mm to 50mm	300mm	750mm
65mm to 100mm	450mm	1000mm

In excavating the trenches, the road metaling, pavement kerbing, etc. shall be carefully placed aside and preserved for reinstatement and the trench or other excavation shall be filled up and laid back to original condition at no extra cost. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the client / consultants. The contractor shall not cut or break down any fence or live trees in the line of the proposed works but shall tunnel under them unless the client orders the contrary. The contractor shall scrub and clear the surface over the trenches and other excavations of all stumps, roots and other encumbrances affecting execution of work and shall remove the same from the site as per the directions of the client.

10.3.9 Excavation to be taken to proper depth

Trenches shall be excavated in all conditions of soil and to such a depth that the sewers / or other pipes shall rest as described in the several clauses relating thereto and so that the inverts may be at the levels given on the section. Should the contractor excavate the trench to a greater depth than is required the extra depth shall have to be filled up with concrete at the contractor's own cost to the requirements and satisfaction of the client / consultants.

10.3.10 Back filling of the trenches (IS: 12288 – 1987)

After the sewer or other piping work has been laid and proved to be water-tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this so that no damage is caused to the sewer and other permanent works.

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench of its top, for the purpose of refill materials to be used.

ZONE A

From bottom level of trench, to the level of the center line of the pipe

ZONE B

From the level of the center line of the pipe to a level 30 cm above the top of the pipe, and

ZONE C

From a level 30 cm above the top of the pipe to the top of the trench.

Backfill materials

All backfill materials shall be free from cinders, ashes, slag, refuse, rubbish, vegetable or organic materials, lumpy or frozen materials boulder, rocks or stone or other materials which in the opinion of the client / consultants, is unsuitable for deleterious. Fine excavated earth which shall pass through a sieve of aperture size 20 mm can be used for filling in zones A & B. However, material containing stones up to 20mm as their greatest dimension may be used in zone C only unless otherwise specified by the clients / consultants. Where excavated material is considered by the clients / consultants not suitable for back filling, clean river sand shall be used for the same.

Backfill sand

River sand used for back fill shall be natural sand complying with para 3.6 graded from fine to coarse. The total weight of clay in it shall not exceed 10 percent. All material shall pass through a sieve of aperture size 20mm (IS-2405-1980) and not more than 5 percent shall remain on IS sieve of aperture size 6.30mm.

Backfill gravel

Gravel used for back fill shall be natural gravel and having durable particles graded from fine to coarse in a reasonably uniform combination with no boulders or stone larger than 50mm in size. It shall not contain excessive amount of loam and clay and not more than 15 percent shall remain on a sieve of aperture size 75 micron.

Back filling in zone A

It shall be done by hand with fine excavated material or river sand, fine gravel or other approved materials placed in layers of 8cm and compacted by tapping. The back filling material shall be deposited in the trench for its full width of each side of the pipe, fittings and appurtenances simultaneously.

Back-filling in zone B

Back filling in zone B using fine excavated material shall be done by hand or approved mechanical methods. Special care has to be taken during tamping to avoid injuring or moving the pipe. If excavated material is not suitable, the type of back-fill material shall be prescribed by the client / consultants to suite individual locations.

Back filling in zone C

It shall be done by hand or approved mechanical methods and well compacted. Excavated earth having stones of size not exceeding 20 mm can be used for zone C. If the excavated earth is unsuitable for back fill, the filling material shall be specified by the client / consultants.

Sand filling

GI pipes in trenches shall be protected with fine sand 150mm all around before filling in the trenches.

Painting

a) All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality to give an even shade, or as specified by the Engineer-in-Charge.

b) Hot water pipes in chase:

All hot water pipes fixed in wall chase shall be properly insulated by elastomeric tape as per manufacturer's recommendation.

Pipe protection

Where specified, pipes below floor or below ground shall be protected against corrosion by the application of two or more coats of solvent based rubberised asphaltic primer to give a uniform coat covered with 'Pipe coat Hiper', a puncture resistant non-woven polyester mat. The application of pipe coat primer and "Hiper" membrane shall be as specified by the manufacturer.

CPVC (CHLORINATED POLY VINYL CHLORIDE) PIPES & FITTINGS

CPVC pipes & fittings solvent welded type shall be used for internal cold & hot water supply piping work. CPVC pipes from 15mm to 50 mm shall be Class - 1, SDR-11 conform to the requirements of IS 15778. CPVC pipes from 65mm to 300 mm shall be schedule 40 / schedule 80 class conform to the requirements of ASTM-F441 & as described in the BOQ/SOQ.

Coefficient of thermal expansion- ASTM D - 696- 6.3×10^{-5} m/m⁰K Thermal conductivity – ASTM C 177 – 0.14 Wm/⁰K/m²

CPVC fittings i.e. sockets, tees, bends, reducers, brass threaded male/female connectors, brass threaded male/female adapters unions, bushings etc shall comply to the requirements of ASTM F438 & ASTM F439 for schedule 40 & schedule 80 class respectively. Solvent cement for CPVC pipe shall comply as per ASTM F493.

CPVC pipe work shall be installed strictly as per the recommendation of manufacturer. CPVC pipe work shall be adequately supported by GI split clamps with GI structural supports & GI threaded rods. CPVC pipe work shall be securely tight with GI nuts, bolts & washers. Pipe work spacing shall be as per guidance of manufacturers.

After completion of piping work, piping shall be hydraulically tested in parts with test pumps at 10bar for 24 Hrs or 1.5 times working pressure, whichever is higher. CPVC test plugs shall be used to seal the dead end of piping. Upon completion of entire installations, the complete system shall be tested as described above.

Upon successful testing of entire piping system, it shall be painted with one coat of approved primer & two coats of approved synthetic enamel paint, as per direction of engineer-in-charge / client.

CPVC Piping Installation Procedure

- a) Pipe shall be cut truly straight to the required length
- b) Remove burr (shaving) & clean the cut portion with dry cloth. Ensure that jointing portion is free from any dirt, grease or any other foreign material.
- c) Install dry fit out, by inserting pipe inside the sockets up to 1/3rd to 2/3rd penetration depths. Ensure that pipe inserts to the bottom of the sockets, without any resistance. If pipe inserts is not to the sockets, then check with another fittings.
- d) Apply a thin coat of solvent cement to the inner side of socket up to its bottom & full coat to the outer side of pipe.
- e) Insert pipe in to the socket, till the solvent is in fluid state. Twist the pipe turn to cover any dry spots.
- f) Hold the pipe for at least 30 seconds, to ensure proper jointing. Wipe out excess solvent cement with clean dry cloth.
- g) Allow joint to cure for at least 24 Hours.
- h) For pipe greater than 50 mm diameter, pipe work shall be jointed with primer & heavy duty solvent cement.
- i) Teflon tape shall be used for threaded portion of fittings.
- j) Manufacturer's recommendation shall be followed during pipe work installations.

Rating & Dimensional Details of CPVC Pipes SDR 11

Diameter & Wall thickness of CPVC pipes SDR – 11 are as per Table given below: -

S.N	Nominal pipe size (mm)	Mean outside diameter			Wall Thickness		
		Min	Max	Mean	Min	Max	Avg Max
1	15	15.8	16	15.9	1.7	2.2	2.2
2	20	22.1	22.3	22.2	2	2.5	2.5
3	25	28.5	28.7	28.6	2.6	3.1	3.1
4	32	34.8	35	34.9	3.2	3.7	3.7
5	40	41.2	41.4	41.3	3.8	4.3	4.3
6	50	53.9	54.1	54	4.9	5.5	5.5

Note: For CPVC Pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm. The SDR values shall be rounded to the nearest 0.5

Pressure rating @230C – 27.6 Kg/cm²

Pressure rating @820C – 7.03 Kg/cm²

(FOR PIPE DIAMETER ABOVE 50MM Sch.40)

Nominal pipe size		Outer Dia.	Inner Dia.	Wall Thickness	Pressure rating
(Inch)	(mm)	(mm)	(mm)	(mm)	(Kg/cm ²)
2 1/2"	65	73.3	62.1	5.16	21.10
3"	80	88.9	77.27	5.49	18.28
4"	100	114.3	101.5	6.02	15.47
6"	150	168.28	153.19	7.11	12.66

Pipes shall be painted with bituminous paint and covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of Synthetic enamel paint. The portion embedded shall be painted with thick cement slurry before fixing. Colour to be verified as per IS standards for all the pipes.

Supports Spacing

CPVC pipe work supports shall be provided as per below table.

Nominal Size	Pipe size	Supports spacing (Meter) respectively with pipe size			
		23 OC	38 OC	60 OC	80 OC
15 mm	SDR 11/ SDR 13.5	1.22 / 1.22	1.22/ 1.22	1.07/ 1.07	0.92/ 0.92
20 mm	SDR 11/ SDR 13.6	1.53 / 1.53	1.37/ 1.37	1.22/ 1.22	0.92/ 0.93
25 mm	SDR 11/ SDR 13.7	1.68/ 1.68	1.53/ 1.53	1.37/ 1.37	0.92/ 0.94
32 mm	SDR 11/ SDR 13.8	1.83/ 1.83	1.68/ 1.68	1.53/ 1.53	1.22/ 0.92
40 mm	SDR 11/ SDR 13.9	1.98/ 1.98	1.83/ 1.83	1.68/ 1.68	1.22/ 0.93
50 mm	SDR 11/ SDR 13.10	2.29/ 2.29	2.14/ 2.14	1.98/ 1.98	1.22/ 0.94
65 mm	SCH 40 / SCH 80	2.13/ 2.86	2.13/ 2.86	1.82/ 1.98	1.06/ 1.22
80 mm	SCH 40 / SCH 81	2.13/ 2.59	2.13/ 2.59	1.82/ 2.13	1.06/ 1.22
100 mm	SCH 40 / SCH 82	2.86/ 2.74	2.86/ 2.74	1.98/ 2.86	1.22/ 1.37
150 mm	SCH 40 / SCH 83	2.59/ 3.04	2.59/ 2.89	2.13/ 2.59	1.37/ 1.52

POLYPROPYLENE RANDOM CO-POLYMER (PP-R) PIPES

The PP-R is a bonded, multilayer pipe consisting of different layers of the pipe:-

- The inner-most layer of the pipe to be Anti – bacterial to prevent bacteria growth inside pipe surface.
- The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct effect of the atmospheric conditions.
- The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight under exposed atmospheric conditions.

The pipes should in general be conforming to the requirements of IS 15801 except that specified with in nomenclature of the item. The pipes should have smooth inner surface with non-contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects.

The pipes shall be clean and well cut along ends after taking into consideration the desired length, using the pipe scissors. The Polypropylene used for manufacturing the pipe shall conform to the requirements of IS 10951 and IS 10910. The specified base density shall be between 900 kg/m³ and 910 kg/m³ when determined at 27°C. The resin should be mixed with sufficient quantity of colour master batches. The colour master batch should be uniform throughout the pipe surface. The standard dimension ratio (SDR) i.e. ratio of the nominal outer diameter of a pipe to its nominal wall thickness should be 7.4/11 as given in the item.

10.5.2 Fittings

Plain fittings, Chrome plated brass threaded fittings and Valves shall be as per nomenclature of item or as directed by engineer-in-charge.

(a) The plain fittings shall be Polypropylene Random Copolymer and comply with all the requirements of the pipes. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded Plug and wall clamps in available sizes.

(b) The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass threaded piece moulded inside Polypropylene random copolymer fitting. The material shall comply with all the requirements of the pipes. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C.P. connections and for continuations from existing Galvanized Iron Pipes and fittings.

(c) The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate Valve, Ball Valve, Concealed stop valve and Chrome Coated Valve in available sizes.

(d) The Valves sizes availability in Polypropylene Random Copolymer is as follows: -

(i) Gate Valve - 20 mm to 63 mm

(ii) Ball Valve - 20 mm, 25 mm, 32 mm, 40 mm, 50 mm & 63 mm

(iii) Concealed Stop valve - 20 mm & 25 mm

(iv) Chrome Coated Valve - 20 mm & 25 mm

However, the other Brass/Bronze Valves can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes

10.5.3 Laying and Jointing of Pipes and Fittings

The pipes and fittings shall run in wall chase as specified. Pipes shall run only in vertical or horizontal alignment as far as possible. The installation of pipes is similar to that of the metal pipes with the only difference in the jointing procedure. The jointing of the PP-R pipes and fittings are done by fusion welding by means of a welding machine.

The marking on pipe shall carry the following information:-

- a) Manufacturer's name/ trade mark
- b) PPR pipe
- c) SDR
- d) Outside diameter and minimum wall thickness
- e) Lot No. / Batch No. containing date of manufacturing. And machine number.

10.5.4 The outside diameter of pipes, tolerance in the same and ovality of pipe shall be as given in Table below.

Sl.No.	Nominal Size	Outside Dia	Tolerance (Only positive tolerance)	Ovality
	DN	mm	mm	mm
i	16	16.0	0.3	1.2
ii	20	20.0	0.3	1.2
iii	25	25.0	0.3	1.2
iv	32	32.0	0.3	1.3
v	40	40.0	0.4	1.4
vi	50	50.0	0.5	1.4
vii	63	63.0	0.6	1.6
viii	75	75.0	0.7	1.6
ix	90	90.0	0.9	1.8
x	100	110.0	0.9	2.2

a) The values specified for tolerance on outside diameter have been calculated as $0.009DN$, rounded off to the next higher 0.1 mm subject to minimum of 0.3 mm. No negative tolerances are allowed.

b) The basis for the values specified for ovality is:

i) For nominal outside diameters ≤ 75 mm, the tolerance equals $(0.008 DN + 1.0)$ mm, rounded to the next higher 0.1 mm, with a minimum value of 1.2 mm.

ii) For nominal outside diameters ≥ 75 mm and ≤ 250 mm, the tolerance equals $0.20 DN$, rounded to the next higher 0.1 mm.

c) For nominal outside diameter > 250 mm, the tolerance equals 0.35 DN, rounded to the next higher 0.1 mm.

Wall Thickness

The minimum and maximum wall thickness of pipes shall be as given in Table below:-

Note: The wall thickness tolerances have been calculated on the following basis:

(a) Limit deviation = $0.1e + 0.2$ mm rounded up to the nearest 0.1 mm.

(b) A local increase in wall thickness of up to $+0.2e$ is permissible for e up to 10 mm and up to $0.15e$ for e greater than 10 mm. The mean of the measurement shall, however, still lie within the given limit deviations.

Sl.no	Nominal size	SDR11		SDR 7.4	
		Min	Max	Min	Max
i	16	-	-	2.2	2.7
ii	20	1.9	2.3	2.8	3.3
iii	25	2.3	2.8	3.5	4.1
iv	32	2.9	3.4	4.4	5.1
v	40	3.7	4.3	5.5	6.3
vi	50	4.6	5.3	6.9	7.8
vii	63	5.8	6.3	8.6	9.7
viii	75	6.8	7.7	10.3	11.6
ix	90	8.2	9.3	12.3	13.8
x	110	10	11.2	15.1	16.9

The quality of each installation system ultimately depends on the tightness, stability and lifetime of its connections. The pipe of the desired length is cut using the pipe scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on - Control lamp and switch lamp will lit. When ready, control lamp gets off, which means that welding temperature of 260 Degrees ± 10 Degrees Celsius has been reached. The pipe end and the fitting to be welded are heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting are cleaned with a cloth. When

heated up (with heating time as per the Table shown below), the pipe CPWD SPECIFICATIONS 2009 824 and the fitting is removed from the welding machine and the two pieces connected by applying a little pressure without twisting. The joint can cool down for a few seconds. The welding process is that safe because the properly heated part of Polypropylene creates a homogeneous connection.

Guidelines for Welding PP-R Pipes and Fittings (DVS Guideline 2207, Part II)

Diameter of pipe(mm)			Heating Time (Seconds)	Cooling Period (Minutes)
16	5	2		
20	5	2		
25	7	2		
32	8	4		
40	12	4		
50	18	4		
63	24	6		
75	30	8		
93	30	8		

The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers may be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on the surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts

Etc. there should be enough space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not but

Installed at bending parts and the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length. For exposed straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.

10.5.6 Piping Installation Support

Piping shall be properly supported by means of wall support clamps as specified and as required, keeping in view the proper designing for expansion and contraction. Risers shall be supported at each floor with clamps. Due to high coefficient of thermal expansion the heat losses though the pipes is highly reduced. Therefore, for internal Bathroom hot geyser water distribution lines, the insulation is often not required

Anchor Blocks

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

Rubber Joints

Joints between two pipes shall be made by pre-moulded rubber joints with suitable tackles in a manner recommended & approved by the manufacturer. No joints shall be covered until the lines are hydraulically tested.

Thrust Blocks

In case of bigger pipes (80 mm diameter and above), thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by the Owner's site representative.

VALVES & FITTINGS

All valves (gate, globe, check, safety) shall be of gun metal suitable for the particular service as specified. All valves shall be of the particular duty and design as specified. Valves shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe and check valves shall conform to Indian Standard IS: 776 and non-return valves and swing check type reflux to IS: 5312.

Sluice valves, where specified shall be flanged sluice valves of cast iron body. The spindle, valve seat and wedge nuts shall be gunmetal. They shall generally have non-rising spindle and shall be of the particular duty and design as specified. The valves shall be supplied with suitable flanges, non-corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian standard IS: 780 and IS: 2906.

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for forged brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

Sl.no	Type of Valve	Size	Construction	Ends
a.	Isolating Valve.	15 mm to 50 mm	65 mm and above	Gun Metal
				Screwed Flanged
b.	Sluice Valve & Butterfly Valve		65 mm and above	Cast Iron
				Flanged
c.	GM non return valve	15 mm to 50 mm	65 mm above	Gun Metal
				Screwed Flanged
d.	Flap Type – Non return valve	65 mm and above		Cast Iron
				Flanged

Gunmetal Valves

Valves 65 mm dia. and below shall be heavy gunmetal full way valves or globe valves conforming to Class I of IS: 778. Valves shall be tested at manufacturer's works and the same stamped on it.

All valves shall be approved by the Engineer-in-Charge before they are allowed to be used in the Work.

Sluice Valves

Unless otherwise specified all valves 80 mm dia. and above shall be CI double flanged sluice valves with non rising spindle. Sluice valves shall be provided with wheel when they are in exposed positions and with a cap top when they are located underground. Contractor shall provide suitable operating keys for sluice valves with cap tops.

Sluice valves shall be of approved makes conforming to IS: 780 of Class as specified.

Butterfly Valves

Where specified, Valves 80 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/ or flow regulation as directed by the Engineer. The valves shall be tight shutoff/regulatory type with resilient seat suitable for flow in either direction and seal in both directions.

Butterfly valve shall conform to IS: 13095.

Non-Return Valve

Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.

Forged Brass Ball Valve

Valves of size 50 mm dia. and below shall be full bore quarter turn lever operated female threaded forged brass hard chrome plated ball valves conforming to IS: 554. Valve shall have PTFE body seat rings and gland packing, forged brass ball, stem and bonnet, carbon steel nut washer and lever and finished in chrome. Valves shall have minimum working pressure of 20 bar. Valves shall be tested at manufacturer's works and the same stamped on it.

Air Release Valve (ARV)

Pressurized water supply lines shall be provided with air release valve at highest point to release accumulated air for piping system. Air release valve shall be automatic float operated, the diameter shall be as specified in the Schedule of Quantities. Air release valve shall be provided with ball valve for ease in Operation and Maintenance. Valve body shall be in cast iron stainless steel, brass and EPDM internal components. Valves shall have minimum working pressure of 20Kgs.

Air release valve shall be installed as per specifications provided in BOQ.

Table Commonly Adopted Size of Air Valves

Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

NON RETURN VALVE

Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.

PRESSURE GAUGE

The pressure gauge shall be constructed of die cast aluminum and stove enameled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourdon tube type pressure gauge with a scale range from 0 to 16 Kg / cm square, 6" dial and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

Calibration certificate shall be obtained and submitted for each pressure gauge, flow meter, pH transmitter, conductivity meter, HP & LP Switch, Diff. pressure switch, level transmitter density meter, etc.

BALL VALVES

Ball Valves have body material as Forged Brass Chrome plated with Spindle Brass Nickel Plating & Lever handle Steel Chrome plated with green plastic cover. The valve is suitable for water maximum working pressure up to 25 bar (PN 25). The valve is operated by turning. The rotation from open to close is a quarter turn (90 degree) which closes in a clock-wise direction.

BUTTERFLY VALVES

The butterfly valve shall be suitable for waterworks and rated Pressure requirement as mentioned in the Schedule of quantities.

The body shall be of cast iron to IS: 210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti-corrosive epoxy or nickel coating.

The valve seat shall be of high grade elastomeric or nitrile rubber. The valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomeric rubber shall have a long life and shall not give away on continuous applied water pressure.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

Butterfly valves of approved quality for pressure rating of 230 P.S.I. with locking arrangement and gearbox with handle operated or gearbox with lid shall be provided or as given in the Bill of Quantities. Butterfly valves shall be of specified quality conforming to IS: 13095 or BS: 5155.

Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.

Solenoid Valve

The high pressure solenoid valve is a two-way type with one inlet and one outlet. It is a pack less, internal pilot operated valve, suitable for use in releasing water pressure from the priming chamber of Deluge Valves and Flow Control Valves. The solenoid valve has floating diaphragm construction, which requires a minimum pressure drop across the valve to operate properly. The valves are available with a voltage rating of 24V DC in a normally closed or normally open configuration. These solenoid valves are for use with system control units that are listed and/or approved for releasing service for water based fire protection systems.

Level Sensors

Level sensor shall consist of control unit, preamplifier and one full insulated probe-mounted vertically or two part insulated probe mounted from tanks side wall adjustable switching system for pump control application, the same to be housed in stove enamel painted cast aluminium weather proof suitable for black panel / wall mounting etc.,

The enclosure of probes shall be manufactured with SS316 material. The least count of the central unit with amplifier should be $\pm 0.10\text{mm}$ for response value of 30 seconds.

Level Indicators

A level control system with electronic level probes is mounted on the face of the reservoir. The top two level sensors provide the ON-OFF signal for the treated water transfer pumps. A third level sensor enunciates a low level alarm condition to the paging system and a fourth sensor enunciates an alarm to the paging system and stops the domestic water pumps from operating.

Pressure Gauge

Pressure gauge shall be provided as shown in drawings. Pressure gauge shall be 50 mm dia gunmetal bourdon type with gunmetal isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability. All gauges in the main fire pump room and ICV stations shall be glycerin filled gauges.

Pressure gauges fitted in the installations shall comply with IS 4224. The scale subdivision shall not exceed

0.2 bar for a maximum scale value up to and including 20 bar

0.5 bar for a maximum scale value of more than 20 bar

1.0 bar for a maximum scale value more than 20 bar.

LEVEL SWITCH

Level switches shall be provided as shown in drawing which is of electro-magnetic type. Level switches shall control/sense liquid in open or pressurized.

WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS: 779 and IS: 2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

(Note: The water meters to be installed and at every use of water such as Landscape irrigation, Domestic, Flushing, Fire fighting etc.)

INSTALLATION OF WATER METERS AND STOP COCK

Lines shall be cut to the required lengths at the position where the meter and stop cock are required to be fixed. Suitable fittings shall be attached to the pipes. The meter and stop cock shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter.

TESTING

All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 10 kg/cm² or 1.5 times the shut off head of the pump whichever is greater.

The test pressure shall be maintained for a period of at least thirty minutes without any drop-in pressure.

A test register shall be maintained, and all entries shall be signed and dated by Contractor(s) and the Engineer.

UNDERGROUND / OVERHEAD STORAGE TANKS

- (a) Storage tanks for water supply shall be in RCC.
- (b) Each tank shall be provided with lockable type manhole cover fabricated from MS sheet or standard cast iron tank covers. Manhole covers shall be of appropriate size as directed by the Engineer-in-Charge.
- (c) Each storage tank shall be provided with high and low level annunciation by means of magnetic level switches. One solid state electronic annunciation panel fully wired with visual display and audible alarm unit shall be provided to indicate the following:
 - High and low level alarms for each water storage tank.
 - On/ off status of all Pump sets namely domestic
- (d) All the necessary arrangements for fixing the panel shall be provided by the Contractor.
- (e) All the cabling from the respective level switches to the Annunciation Panel, MCC Switch gear to Annunciation Panel, including power supply from MCC shall be provided by the Contractor.
- (f) The number of outgoing terminals shall be equal to the number of incoming terminals from field/ MCC with 20% margin, so that necessary interconnection to BMS could be done at a later date.

TESTING

- (a) All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 20 kg/cm² or 1.5 times the shut off head of the pump whichever is greater.
- (b) The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.
- (c) A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.
- (d) After commissioning of the water supply system, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.
- (e) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

INSULATION

All open hot water flow and return pipes shall be insulated with preformed fibrous pipe sections conforming to IS: 9842.

Insulation to pipes shall be with pre-moulded pipe sections, thickness for sections shall be:

- a) Pipe 50mm diameter and below - 25mm thick
- b) Pipe 65mm diameter and above - 40mm thick

Application:

- a) All surfaces shall be thoroughly cleaned with a wire brush.
- b) One layer of approved primer shall be applied and pre-moulded pipe insulation sections shall be fixed.
- c) One layer of aluminium foil of thickness 0.711mm (20 SWG), shall be applied as a finish layer.

Insulation for hot water pipes in chase:

All hot water pipes in chase shall be insulated with 3 mm elastomeric tape as per manufacturer's recommendations.

DISINFECTION OF INSTALLATION

The water supply installation shall be disinfected as per standards and as follows:

- a) Tanks and pipes shall be filled and flushed out.
- b) All bib cocks (taps) shall be closed.
- c) Tanks and pipes shall be re-filled while adding sterilizing admixture containing 50 parts chlorine to one million parts water.
- d) When the installation is filled all bib cocks (taps) shall be opened progressively and each allowed running until the water smells of chlorine.
- e) The installation shall be topped up and more sterilizer added.
- f) The installation shall then be left for three hours and shall then be tested for residual chlorine; if none is found, the installation shall be drained and the process repeated.
- g) The installation shall be finally drained and flushed with potable water before use.

CONNECTION TO RCC WATER TANKS. (PUDDLE FLANGE)

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as

called for. All pipes crossing through RCC work shall have puddle flanges fabricated from GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of an approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating with bronze screen on vent.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

The floor and the walls of the tank shall be tiled with glazed tiles up to the overflow level. Alternatively food grade epoxy to be applied.

DISINFECTION OF PIPING SYSTEM AND STORAGE TANKS

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described in the succeeding paragraph.

The water storage tanks and pipes shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give water a dose of 50 parts of chlorine to one million parts of water.

If ordinary bleaching powder is used, the proportions will be 150 gm of power to 1000 litres of water. The power shall be mixed with water in the storage tank. If a proprietary brand of chemical is used, the proportions shall be specified by the manufacturer. When the storage tanks are full, the supply shall be stopped and all the taps on the distributing pipes are opened successively working progressively away from the storage tank. Each tap shall be closed when the water discharged begins to smell of chlorine. The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommended proportions. The storage tank and pipe shall then remain charged at least for three hours. Finally the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

The pipe work shall be thoroughly flushed before supply is restored.

DISINFECTION OF INSTALLATION

The water supply installation shall be disinfected as per standards and as follows:

- (a) Tanks and pipes shall be filled and flushed out.
- (b) All bib cocks (taps) shall be closed.
- (c) Tanks and pipes shall be re-filled while adding a sterilising admixture containing 50 parts chlorine to one million parts water.
- (d) When the installation is filled all bib cocks (taps) shall be opened progressively and each allowed to run until the water smells of chlorine.
- (e) The installation shall be topped up and more steriliser added.
- (f) The installation shall then be left for three hours and shall then be tested for residual chlorine; if none is found, the installation shall be drained and the process repeated.
- (g) The installation shall be finally drained and flushed with potable water before use.

STERILIZATION OF MAIN

After the pipe work has been tested and approved, but before it is coupled, it shall be sterilized with a solution of chloride of lime. The water supply installation shall be sterilized as per standards and as follows:

- a) Tanks and pipes shall be filled and flushed out.
- b) All bibcock (taps) shall be closed.
- c) Tanks and pipes shall be re-filled while adding sterilizing admixture
containing 50 parts chlorine to one million parts water.
- d) When the installation is filled all bibcock (taps) shall be opened
progressively and each allowed running until the water smells of
chlorine.
- e) The installation shall be topped up and more sterilizer added.
- f) The installation shall then be left for three hours and shall then be
tested for residual chlorine; if none is found, the installation shall be
drained and the process repeated.

CUTTING CHASES IN MASONARY WALLS

Cold water distribution pipes to fixtures and equipment exposed to view in the toilets, pantry, and sanitary compartments shall be chased into walls or floors or placed in wall cavities. The Contractor shall be responsible for cutting all notches, chases, and recesses in walls and floors and only a diamond cutter shall be used. The maximum size of conduit or pipe permitted to be concealed in floor slabs shall be 32 mm diameter unless otherwise approved by the Architect.

The chases up to 7.5 x 7.5 cm shall be made in the walls for housing GI pipes etc. These shall be provided in correct positions as shown in the drawings or directed by the Architects. Chases shall be made by chiselling out the masonry to proper line and depth. After the pipes etc. are fixed in chases, the chases shall be filled with cement mortar 1:2:4 or as may be specified and made flush with the masonry surface. The concrete surface shall be roughened with wire brush to provide a key for plastering.

Where pipes pass through beams or structural walls, subject to the approval of the Structural Consulting Engineer, the Contractor shall ensure that sizes and locations of openings required are formed in when the relevant beams or walls are cast.

INSULATION

The insulation for hot water pipes shall be done as specified in Bill of Quantities and accordingly following guidelines shall be followed:

For Chased Internal Pipes:

All open hot water flow and return pipes (not in chase), shall be insulated with preformed fibrous pipe sections conforming to IS: 9842. Hot water pipes fixed in chase shall be insulated by wrapping 6 mm thick thermal insulation tubing's.

Elastomeric nitrile rubber closed cell pipe insulation for hot water supply pipe.

For External Piping:

Exposed pipes, on terrace and along ceiling level shall be insulated with either thermal tubing's of specified thickness or fibre glass wool blankets/mats, as specified in Bill of Quantities. After the insulation, all the pipes shall be protected with either 12mm thick smooth finished cement plaster (two layers of 6 mm thick of mix 1:2 Portland cement and fine sand) or they shall be clad with 24 SWG aluminium sheet as specified in Bill of Quantities.

The specifications of the material shall be generally as follows,

unless specified:

- a) Fibre glass wool -- Blankets/mats of 50 mm thickness in the density of 24 kg/m³
- b) Elastomeric Flexible Material-- Thermal Insulation tubing's of 6mm thickness with density of 60-90 Kg/m³.

Generally, following procedure shall be adopted:

- a) Cleaning the pipe surface to be insulated to make it free from dust & oil.
- b) Applying a layer of zinc chromate/anti- rust c.
- c) Fixing fibre glass wool blankets or mats/Elastomeric Flexible Tubing's as specified.
- d) Covering it all around with 24 gauge "wire netting with proper butt joint and tightly wrapped.
- e) Applying two layers of 6 mm thick each cement plaster in the ratio of 1:2 (1 cement: 2 fine sand).
- f) Applying weather proofing coating of Inculcate (Paints) OR of approved material over the cement plaster.
- g) For certain places, where exposed insulation is not to be plastered as specified in item (v) and (vi), then aluminium foil sheet of 24 gauge with 50 mm overlapping, fixed with self tapping recessed screwed shall be provided.

PAINTING / PIPE PROTECTION / INSULATION

Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear metre along the center line of the pipe,

over the finished surface and shall include all valves and fittings for which no deduction shall be made.

11.36 AIR RELEASE VALVES

Air release valve shall be installed as per specifications provided Table Commonly Adopted Size of Air Valves

Size of Main mm	Type of Valve	Size of Air Valve mm
80	Single air valve	20
100	Double air valve	40
125-200	Double air valve	50
250-350	Double air valve	80
400-500	Double air valve	100
600-900	Double air valve	150
1000-1200	Double air valve	200

- a) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.
- b) Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

11.37 PRE COMMISSIONING

10.37.1 Ensure that all pipes are free from debris and obstructions.

10.37.2 Check all valves for effective opening and closing action. Defects should be rectified or valves replaced.

10.37.3 Ensure that mains have been connected to the respective pumps,

underground and overhead tanks.

Water supply should be available at main Underground tank.

All main line Valves should be closed.

COMMISSIONING

Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the Raw Water tanks and then overflow to the fire water tank.

After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).

Fill Overhead tank to full.

Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.

Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve. The entire water supply system should be disinfected with bleaching powder and system flush cleaned.

Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

5B.6.12. PUMPS (HYDROPNEUMATIC SYSTEM & PUMPING MAINS)

12.1 SCOPE

This section of the contract involves the design, supply, installation, testing and commissioning of the complete Hydro pneumatic pumping system and other pumping systems complete with all controls and electrical work for domestic water supply, flushing water supply. All submersible & drainage pumps for the project are also included in this contract. It also involves testing and commissioning of the pumping system with the domestic water, flushing water supply and drainage & distribution.

This specification described the particulars of the contract, designs and systems chosen, and mode of operation.

All installation work shall comply with the latest rules and regulations.

The work embraced by this specification covers the design, submission to authorities, supply, and delivery on site, installation, testing, commissioning and maintenance of the Hydro pneumatic pumping system, other pumping system installation of the building in accordance with this specification and associated drawings.

The scope of work shall include the following:

- Variable speed pumping unit domestic water,
flushing water supply & distribution.
- Suitably sized food grade quality, non-toxic diaphragm type pressure
vessels complete with necessary interconnections and controls.
- Control panel for pump control complete with variable speed drive,
circuit breakers, fuses, pressure transmitters etc. complete with all
interconnections to pumps and electrical supply panels.
- Pump control unit complete with pre-programmed logic controller.
- Pump monitoring units to monitor operation of pumps.
- Each Hydro pneumatic Pumping unit shall be supplied as a complete
set including variable speed pump, pressure vessel, suction and
discharge common G.I. manifolds, non-return valves, isolating valves,
pressure transmitter on the discharge side and level electrode at the
suction tank. Each unit shall be provided with PLC for unit control and
all necessary electrical work for the unit.

- Submersible storm water/drainage pumps (de-watering) for plant room drainage, Sewage pumps complete with electrical panels and necessary accessories with automation for pump operation.
- All the pipe work etc. shown in the system drawings is meant for information only and shall be carried out by others. The Hydro pneumatic system supplier shall provide the pumping units in the designated pump rooms as complete units included all necessary piping within plant such that only discharge connections are required to be connected into the unit's suction & discharge manifolds just inside the plant room, by the Plumbing contractor. The Hydro pneumatic system contractor shall guarantee specified pump performance at various pump speeds and Hydro pneumatic pumps must be able to supply at least 2 bar pressure at the highest/farthest fitting.
- Electrical equipment and installation work including the PLC in Control panel.
- Painting and labelling of pipe work and equipment;
- Provision of all hold down bolts, spigots struts and the like required to be built in during construction;
- Provision of potential free contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each pump room and control panels of all pumps.
- Provision of all level switches, flow switches and other sensing devices for status indication.

- All interfacing work with other trades.
- Testing & commissioning and balancing of the Hydro pneumatic & pumping system;
- Provision of twenty four (24) months operational maintenance and breakdown services;
- Provisions of operating instructions and maintenance manuals;
- Provision of spare parts;
- Training of the employer's staff for proper operation of the entire systems;
- Liaison with Local Authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;
- Provisions of the necessary installation which include pumping works, pipe work within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;
- All other works and systems as specified in the specifications and or shown on the drawings.

- All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe diameter, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sealant compound on either end. Details on shop drawings shall also be provided.

12.2 GENERAL

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and/or discharge guard

rails, safety railing, effective earthing of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

12.3 PUMPS FOR WATER SUPPLY & STORM DRAINAGE SYSTEM

(a) Hydro-pneumatic Pumps for domestic and flushing water supply

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of pump with pump head & base of cast iron, Shaft of SS-316 and other parts in SS 304 shall be made for pumps required in Hydro pneumatic System. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

The Contractor shall supply and install pumps of the type and performance as shown on the drawings. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable.

Leakage from pump gland shall be drained to the nearest floor waste.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction, concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.

(b) Vertical Multi-Stage Pumps

Multi-stage pumps shall be of centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft.

Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with rigid universal couplings.

The shafts shall be stainless steel. Stainless steel diffuser shall be provided to protect the shaft in the water space and through the mechanical sealing.

The bearings shall be of ball or roller type protected against ingress of water, dirt and other matter.

Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.

The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal. Pump motors above 7.5 KW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class "F"

insulation and IP55 rating and shall be provided with built-in thermostats for protection against overheating.

Variable Speed Hydro Pneumatic Pumping System

Variable speed Hydro pneumatic pumping units shall be provided for supply of domestic water, flushing water supply for the project. The units shall be selected so as to provide at minimum of 2 bar pressure at the highest/farthest fitting in each plumbing system, the unit serves. The hydro pneumatic pumping units shall have the following features;

System Description

The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and flow sensor levels at the suction tank.

The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. If the demand increase, the flow begins one of the pump starts at low speed and as per demand increase the VFD changes/increases its frequency and in turn the pump increases its RPM. However, should the system pressure be still below the pre-set value, the controller continuously increases pump speed to meet the system demand. When the lead pump is not able to meet the system pressure at full speed, the second pump also starts to operate.

At peak demand all the pumps operate, similarly, if there is a drop in water demand the duty pump speed starts to reduce, then standby pumps cuts-off, followed by stopping of the duty pump.

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.

The system shall be under the control of PLC.

A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via control circuit.

The system shall incorporate a frequency converter or frequency converter motors on the pumps and the pressure transmitter shall register the actual pressure on the discharge side.

The variable speed drive pumping system shall maintain a constant pressure regardless of the system demand. If there is a drop in pressure outside the preset point, the Variable Speed Drive (VSD) pump shall start to run until the pressure increases to the preset limit, or it will continue to increase the pump speeds to the upper limit of the frequency. If the water system demand still cannot be met, the second pump shall be called in to run, the VSD will then alter the pump speed to meet the preset pressure point. If the set point is still unable to be met, the third pump is then activated to run (in case of 3 pumps units).

This shall be achieved by continuously varying the motor speed of the duty pump according to the demand up to a maximum designed capacity.

The range of operation for the VFD will depend upon the make and model of the VFD to be used in the Hydro-pneumatic system.

Under decreasing hydraulic demand, the reverse sequence to the above description shall apply.

The PLC shall ensure alternation of all the duty and standby pumps for even running hours for all the pumps.

The frequency converter shall be linked to the motor of the duty pump for continuous speed adjustment and ultimately the water delivery shall be maintained at constant pressure at the pre-set value.

Contractor shall ensure water level indicator interfacing and its compatibility with the hydro-pneumatic control system.

(c) Local Motor Control Panel

The motor control panel shall be equipped with all the necessary electrical components including a microprocessor control unit and a frequency drive. The control panel and the microprocessor shall cover the followings functions:

- Flexibility and simplicity in allowing the necessary re-adjustment of the pumping system pre-set delivery pressure to operate the pumps within the specified maximum and minimum delivery ranges.
- Built-in frictional loss compensation factor which will automatically increase the delivery pressure setting, in collaboration with the increase in flow demand. This shall be able to minimize the system pressure differences and provide a more constant pressure along the supply line and also to save the energy consumption of the motor when running at low speed.
- Automatic changeover of the pumps to be controlled by the PLC which dictates the duty and standby pumps to run at variable speed.
- Built-in clock functions with weekly programming and with switch on system to operate at least 10 different pre-set pressure points as required.
- When the system has not been operated for more than 24 hours, it shall automatically start the pumps for a few seconds/day to ensure the pumps readiness at all times. The standby pumps shall be activated upon failure of duty pump(s). In event of control failure, the pumps shall be able to be start/stopped manually at the local panel by means of pressure switches.
- The PLC control panel shall be able to cut-off the pumping system when excess pressure is registered in the discharge common manifold.
- The system shall have the capability of receiving input signal concerning reduced water level in suction tanks and shall have control mechanisms to prevent the pumps from running dry.
- Automatically starting the pumps when the water level is back to normal.
- In case of pump failure due to motor overload, the standby pump is switched on automatically. Alarm signal is displayed on the LCD Display unit and alarm lights are activated. The signals shall be interfaced with the BMS through RS-485 MODBUS.

- Functions to limit the no. of 20 start/stop of pumps minimum per hour.
- The system control panel shall incorporate at least the following components:
 - a. LCD Display
 - b. Pumps selections for up to 4 pumps so that system controller can control up to 6 pumps
 - c. Pump status button to display duty pump speed and system capacity
 - d. Zone status button to display operating parameters for different pumping units
 - e. Setting button to input preset pressure, system start/stop time etc.
 - f. ± 1 button to key in numeric data such as pressure set point, etc.
 - g. Enter button for confirmation of input into the system
 - h. Alarm button to show location of fault - self diagnostic function display
 - i. Hour Run measurement for each supplied pump set
 - j. Buttons for scrolling to select the actual display reading for system configuration, i.e. up and down scroll concept.
 - k. Necessary devices for programming, supervising and monitoring operation data/system, status shall be incorporating into the control panel.

List of I/O points needed for interfacing by the system like high level, low level, trouble signal, and details of communication protocol etc. shall be referred from BMS specifications.

(d) Operations Local control panel shall perform as follows:

Auto mode

The desired delivery pressure within the range specified shall be set at the duty local control panel. The pressure transmitter shall detect the delivery pressure continuously within 1 second and feedback to the microprocessor which will control the variable speed drive frequency converter for speed control of the duty pump. When demand increases, the subsequent pumps in the system will be activated to boost up the pressure. Ultimately the duty pump set shall be operated fully automatically to maintain the delivery pressure constantly at the desired set value.

Manual Mode

The on/off function of the pumps shall be manually adjusted at the microprocessor located at the local control panel.

Frequency Control By-pass Mode

All the pump sets shall be started/stopped automatically with the pump output at fixed maximum rotational speed. All the control and protection functions shall remain active. The cut in/cut out pressure shall be internally calculated by the microprocessor for each pump.

(e) System Features

The required performance features of each Hydro pneumatic pumping unit shall be as follows:

System Configuration

Variable speed pumps with pressure vessels.

Control panel consisting of the following components:

The controller which is mounted on a control panel comes with a keypad and display screen mounted on its out door.

In addition to the electronic pump controller, the control panel includes circuit breakers for each pump, the control circuit and control relay for alarm functions auto / manual options.

Pump run Indication

Pump Fault Indication

Visual Alarm

Audible Alarm

Phase Monitor

Lightning Protection

Dry Run Protection

Single Phase Preventer

BUS Communication - Optional

Pump elapsed time monitoring.

Set Point

Ten separate pressure “set points” shall be able to be programmed into the PMU, and switching between set points is timed by a real time clock when a lower pressure is acceptable during certain periods, for instance after hours or weekends, the set point shall be lowered to minimize power consumption.

An external input shall also be used to switch between set points, or manually adjust a set point at any time.

Friction Loss Compensation

It shall be possible to allow for the friction loss component of the system, calculated at full flow and set as a percentage of the set point which will reduce the working pressure of the pump set depending on the actual no. of pumps in operation. A linear approximation of system resistance curve can therefore be allowed for, and pressure will automatically increase as system flow and subsequent frictional losses increase. As such power consumption shall reduce which is required for the pumping system.

Displays

Through the PLC keypad all variable parameters shall be adjustable, current status of settings and measured values shall be able to display on the 2 line x 24 character liquid crystal display.

Individual menus shall be available for monitoring individual pumps, zones, settings, alarms and ON/OFF functions.

Pump Status

Running hours of each pump

Actual pump status (running, not available, standby, allocated to zone, fault) Maximum head of pump at zero flow.

Zone Status

This menu shall be the main operating menu where at the setting and operating parameters can be viewed,

- Current operating set point
- Measured values in the system
- Operating capacity in terms of total output
- Mode of operation for the zone

- Clock programs (relating to set point pressures)
- Standby pumps
- Pump change over time
- Zone configuration
- Pressure transducer scaling
- Friction loss compensation
- Pump priority
- Inlet pressure measuring (if required)
- System response times
- Allowable number of starts per hour for the pumps
- Minimum limit (loss of water, burst mains protection) Setting Menu
(Set)

In this menu all parameters for the operation of the pump set shall be able to be adjusted as required.

- a. Set points (up to 10)
- b. On/Off function (used to prevent unnecessary cycling at low demands)
- c. Displayed pressure units (Bar, PSI, mBar, kpa)
- d. Real time clock programming for any time of the day, week, or weekend
- e. Zone configuration
- f. Friction loss compensation Alarm

The alarm menu shall display all faults that occur during operation, logging the time and date of when the fault occurred and when it was corrected, or whether it is still an actual fault, up to 10 faults can be maintained as history in the controller. The following type of faults shall be diagnosed by the controller.

- a. Mains failure

- b. Frequency converter fault
- c. Analogue input (pressure transducer) fault
- d. High discharge pressure fault
- e. Low discharge pressure fault
- f. Motor thermal overload fault

Variable Frequency Drive

Variable frequency drive shall be of a reputable make acceptable to Project

Manager and shall be complete with RFI filter and harmonic dampers. Enclosure

An IP 54 powder coated steel enclosure shall house all the electrical components.

The enclosure can be supplied loose for remote mounting, or mounted on a common base with the pumps; it shall be adequately ventilated for use in conditions up to a maximum ambient temperature of 45 degrees Celsius.

Electrical Component

All circuit breakers, thermal overloads and contactors shall be of reputable make acceptable to the architect. Electrical supply to the pump controller shall be protected using an isolating circuit breaker.

Method of Starting

The panel shall be built to start the pumps in suitable starting modes, i.e. D.O.L., Star/Delta, or using Soft Starters.

Quality and Testing

Manufacture of the pumps, plus design and assembly of the complete packaged Hydro pneumatic pumping system shall be factory assembled and the pump station shall be fully tested

hydraulically and electrically prior to dispatch to site. Test reports etc. shall be submitted for review before dispatch.

Pump Indicator

The following audible and visible indication shall be provided at the pump local control panels as applicable:

- a. Red "overflow level" indicator with buzzer for the associated water tanks;
- b. Amber "extra high water level" indicator for the associated water tank;
- c. Amber "high water level" indicator;
- d. Amber "low water level" indicator;
- e. Red "pump trip" indicator for each pump;
- f. Green "pump on" indicator for each pump;
- g. "Pump electrical supply healthy" indicator for each pump;
- h. Amber "remote/local" status indicator.

12.4 Sump Pump (De-Watering) –

Submersible

These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached.

Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. casing and C.I. two vane open type with a dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc. it will be of semi open type. The MOC of the sump shall be in accordance to schedule of quantity.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phases, 50 Hz A.C. power supply.

Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

Pump shall be provided with all accessories and devices necessary and required for the pump to make it a complete working system. Each sump pump shall have all isolation valves, check valve on delivery line etc all complete.

Sump pump shall be complete with level controllers, power and control switch gear, Auto/off/Manual switches, pumps priority selections and control and power cabling up to motor and controller/probes etc. (Including earthling). Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indications. Submersible pumps shall be provided / included with float switches, control panel, SS 304 guide rail, SS 304 lifting chain, pump pedestals.

Motor Design

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree C or 311 degree F) for general usage and class 'H' insulation (180 degree C or 317-8 grade 2) for submersible type.

The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel.

The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour.

Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

5B.6.13. Material Specification

Below mentioned is the material specification for all the system:

SL.NO	SYSTEM DESCRIPTION	MATERIAL SPECIFICATION
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[1]	DOMESTIC AND FLUSHING WATER SYSTEM	
(a)	Domestic and flushing external ring main up to building.	GI Class “C” Heavy Duty as per IS 1239.
(b)	Domestic and Flushing piping Inside shafts.	UPVC Sch-80.
(d)	Hot water supply and return pipes	PPR – Grade R200P 4703
(e)	Hot water supply pipes insulation	Elastomeric nitrile rubber insulation
(f)	Domestic and Flushing piping Inside toilets (drivers toilet)	CPVC SDR 11 and schedule 40.
(g)	Ball valve	Gun metal / Forged Brass
(h)	Gate valve, check valve and pressure reducing valve	Gun Metal/CI/Brass
(i)	Sluice valve, butterfly valve and strainer	Cast Iron
(j)	Pressure reducing valves	Bronze body
[2]	SOIL, WASTE AND RAIN DRAINAGE	
(a)	Inside shaft	UPVC SWR
(b)	Sewage pumping main line	DI K9 pipes
(c)	Inside toilet	UPVC SWR, Type / Grade B
(d)	Kitchen waste pipes & fittings	CI hub less pipe.
(f)	Rain water pipe	HDPE IS 14333 pipes and fittings/ CI hub less pipes
(g)	Floor trap and floor cleanout	PVC/Stainless Steel
(h)	Rain water outlet	Cast Iron
(i)	Car Park drain	Cast Iron
(j)	Floor trap and floor cleanout	PVC/Stainless Steel
(k)	Sanitary wares, fittings and fixtures	TOTO, Hindware with Jaguar CP Fittings.
(l)	Pressurize drainage pipes	UPVC Schedule 40

