SECTION A – Civil works

Earthwork and Excavation

## Specifications for Earthwork and Excavation

1. **Scope**

 **The Scope of work** includes but not limited to removing shrubs, tree roots, clearing of the site, excavation of basement pits, backfilling, disposal of surplus earth as required including dewatering, shoring and strutting.

 **Contractor shall provide** all tools & plants, labours, equipment, operations and incidentals necessary and required for completion of all aspects of work covered in these specifications. If required, Contractor shall deploy mechanical means of excavation and transportation of earth.

1. **Types of Soil**

 Contractor shall thoroughly acquaint himself with the type of soil in excavation by an inspection of nature of the ground at site and scrutiny of the soil investigation details available with the owner and the consultant.

 All soils shall be taken as ordinary soil unless rock/hard rock, old masonry or concrete are met with.

1. **Clearing The Site**

 The site on which the structure is to be built shown on the drawing and the area required for setting out and other operations like roads, drains, sheds, etc. should be cleared and all obstructions, loose stones, materials and rubbish of all kinds, stumps, brush wood and trees removed as directed, roots being entirely grubbed up. All useful materials obtained will be the property of the owners and will be handed over to the Owner. The Contractor will remove rejected materials to his own dump.

 Destroy all ants’ nests and vermin encountered during excavation. Anti-termite treatment shall be applied in accordance with the manufacturer’s recommendations. The Contractor shall submit proposals for treatment. All materials shall have approvals from Owner / PMC.

1. **Ground Levels and Site Level Plan**

 Before starting the excavations, block level plan showing all the ground levels of the entire plot shall be taken, recorded and jointly signed by the Contractor and the Owner/PMC.

1. **Setting Out**

 After clearing the site, and preparing the site level plan, the Contractor will set out the excavation in accordance with the Excavation Setting-out Plan and get the same approved from the Engineer In-charge prior to commencement of the excavation.

 It shall be the responsibility of the Contractor to install substantial reference marks; bench marks etc. and maintain them as long as required by the Engineer In-charge. The Contractor will assume full responsibility for proper setting out, alignment, elevation and dimension of each and all parts of the work.

1. **Excavations**
2. **General**

 The excavations shall be dug to the dimensions as shown on the approved drawings.

 The excavated material shall be stacked at a sufficient distance away from the edge of the excavated pit so as not to endanger the stability of the sides. The drawings show the locations for the stockpiling of the suitable materials.

 The contractor shall, at his own expense and without any extra charge, make provision for all shoring and strutting, extra excavation in slope, extra excavation for working space, dredging or bailing out water, and the excavation shall be kept free from water.

 If excavation is carried out to greater width, length or depth than specified, the area concerned shall be made up by filling the extra length or width as directed by the Engineer In-charge. Cost of such extra excavation and the filling required therein as specified above shall be borne in full by the contractor.

 If required to protect the sides of the excavation, timber shoring and strutting shall be erected. The timbering shall be closed or open depending on the nature of the soil and work, and arrangement of timbering including sizes and spacing of members used shall be as approved by the Engineer In-charge. No extra charges shall be admissible on this account.

 The bottom of all excavations shall be trimmed and levelled in accordance with the drawings/directions of the Engineer In-charge.

 In case, the excavation is done through different strata and if the same is payable as per provision in the Schedule of Items, the Contractor shall get the dimensions of the strata payable decided from the Engineer In-charge . If no specific provision is made in the Schedule of Items it will be presumed that excavations shall be in all types of soil and the Contract's rate shall cover for the same.

1. **Protection**

 All excavations shall be strong fenced and posts warning red lights and signs to avoid any mishap/ accident.

 Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures and services. All necessary measures required for the safety of the people working in and near the foundation trenches, property, and in the vicinity shall be taken by the Contractor at his own cost.

1. **Damage to existing services**

 The Contractor has to indemnify and hold harmless the employer against damage whatsoever caused to adjacent structures and services during construction operations. The Contractor shall be wholly responsible for any injury and damage to property caused by his negligence or accident due to his constructional operations.

1. **Stacking of excavated materials**:

 Excavation shall include sorting out of useful materials and stacking them on site as directed. Materials suitable and useful for backfilling, plinth filling, levelling of the plot or other use shall be stacked in convenient places but not in such a way as to obstruct free movement of men, animals and vehicles or encroach on the area required for constructional purposes.

1. **Submittals**

 The contractor shall submit for Owner/PMC approval submittals of all materials before execution of the works. The submittal shall include name of suppliers and result of the tests required to be carried out to satisfy the requirements of the specifications of the materials.

1. **BACK FILLING**
2. Backfilling in sides of trenches and basement pits shall be done with soil approved by the Owner/PMC. The soil used for this purpose shall be taken from either from excavated earth or from outside the site and shall be done in layers.

1. **Quality of fill**

Fill shall be of well compacted, well graded earth or sand and shall be free from tree stumps, organic matter, seed and peat etc. Where earth or sand from source other than excavation at site is used, the quality of such earth or sand shall be the same as that obtained from excavation at site, or superior to it.

Agricultural soil shall be sweet soil obtained from an approved source free from stone, chlorides, sulphates and shall be suitable for plant growth.

1. **Compaction**

The fill shall be spread in layers not exceeding 300 mm thick and each layer shall be watered and thoroughly consolidated by suitable mechanical rollers, road rollers, surface vibrators, rammers, or other approved plant or system of compaction. Optimum moisture content shall be maintained for the fill materials. Compaction shall be done so as to achieve a dry density of not less than 90% of the maximum density obtained at optimum moisture content, except for the upper 200 mm layer which shall be compacted to a density of not less than 95% of the maximum density.

In order that the fill shall be reasonably uniform throughout, the material shall be dumped in place in approximately horizontal layers. "End dumping", a process by which the material is pushed off edge of the fill and allowed to roll down the slope shall not be carried out. If there is traffic over the fill during construction, either by construction equipment or otherwise, it should be routed to make the compaction as uniform as possible. Where necessary symmetrical filling load shall be maintained and also care shall be taken to prevent any wedging action.

1. **Dewatering**

 Rate for excavation shall be deemed to be inclusive of such local dewatering or pumping out water which may accumulate in the excavation during the progress of work either from subsoil, seepage, springs, rain or any other cause and diverting surface flow if any by bunds or other means. Pumping out water shall be done in a manner approved by the Owner/PMC.

 Dewatering of subsoil, rain water and surface water is being done by the excavation contractor to maintain the pit dry and free of water. After taking over from the excavation contractor, it will be the Contractor’s responsibility to keep the pit dry during construction. Dewatering system shall be designed and implemented by the Contractor with adequate redundancy in deployment of numbers and capacity of dewatering pumps. The system designs will be submitted and got approved from Owner’s Representative before implementation. Dewatering system shall be in place within four weeks of date of commencement during which period excavation contractor will continue to maintain & operate his dewatering system. Contractor’s dewatering system shall be robust and reliable to permit sub-structure work during rainy season.

1. **Other Excavation**
2. Where a good bottom is not obtained within the depth specified or soft pockets are found below formation level (such areas shall got inspected/recorded by Owner/PMCs), additional excavation (if approved by Owner/PMC), shall be made and shall be filled with approved fill or mass concrete as directed by the Owner/PMC.
3. All bottoms of rock excavations shall be examined for loose or broken rock, which shall be removed to provide a solid bearing and the rock surface cleaned and levelled as directed by the Owner/PMC.
4. The bottom of excavation shall be inspected by the Owner/PMC and must be approved by him before any concrete is placed in them.
5. The bottom of excavation shall be trimmed and levelled in accordance with the drawing. Final trimming and levelling shall be done by hand immediately before concrete is placed. Following completion of the excavation, care must be taken to avoid softening of the surface before concreting.
6. **Surplus Excavated Material**

All excavated material certified as surplus and not useful shall be removed by the Contractor at his own expense from the site in an approved manner to an approved dump.

1. **Site Quality Control**

The Contractor has to provide facility for soil testing in site testing laboratory to undertake testing as specified:

Perform the following tests to relevant IS Code and any additional test as may be required.

1. Sieve Analysis
2. Plasticity Index determination
3. Chemical content determination, dry density determination.
4. Both sub base and road base filling shall be tested for CBR at 95% maximum

dry density for each 100 cum of fill material (minimum eight samples each).

1. **Control Tests Of Compaction**:

Each layer of imported fill is divided into 2000 sqm control sections, or such other size as directed by the Owner/PMC for which the following testing shall be performed by the Contractor:

1. Five in- situ dry density tests in accordance with relevant IS Code in representative locations.
2. Average degree of compaction in any central section shall be at least 100% and no single value shall be less than 98%.
3. **Protection and Maintenance**

The Contractor has to protect / maintain:

1. Newly graded or compacted areas from traffic and erosion.
2. Keep fill free from waste and debris.
3. Repair and re-establish grades in silted, eroded and rutted areas.
4. Re compact disturbed areas to required density prior to further construction.

## Specification for Rubble Soling

1. Material

Rubble for Soling shall be locally available stone or other approved variety. It shall be hard, durable and free from defects such as fissures etc.

1. **Execution:**

After excavation / filling has been performed to the required levels, rubble shall be handset as closely as possible and packed well. Rubble shall be laid to have their largest area resting on the sub-grade. Unless otherwise shown on the drawing, rubble packing shall be in one layer of 200/ 250 mm thick. After the stones are packed in position, the interstices between them shall be carefully filled with stone chips of appropriate required size. These shall be hammered in to obtain a finished hard, compact and levelled surface. More spreading of loose spalls or stone chips are strictly prohibited.

Under no circumstances, filling in voids with murrum, sand or such other material shall be permitted. The soling so laid shall be compacted with power roller of 10MT capacity.

1. **Finishing:**

The top surface shall be scarified with wire brush and broom to remove all dusty particles and foreign matters. The surface shall be blinded with approved stone dust as shown in the drawing or approved by the Owner/PMC.

1. **Inspection:**

The surface, before and after the soling shall be examined by the Owner/PMC and written approval taken before proceeding further.

## Specifications for Antitermite Treatment

1. **General**

Prevention of termite from reaching the superstructure can be achieved by creating a chemical barrier between the ground and the building by treating the soil beneath the building and around the foundations. The work shall be carried out as per IS 6313 Part II of 1981 and other relevant codes.

1. **Material**

Chloropyrifos Emulsifiable concentrates of 20% with 1% concentration

1. **Chemical Treatment**

This is a process in which chemical treatment is done to the soil in the early stages of the construction.

1. **Quality Assurance**

 **Installer qualification**

Professionals with minimum 5 years experience in this type of work only shall be employed to carry out the anti- termite treatment required.

 **Submittals**

The Contractor shall submit the manufacturer’s printed product data and application instructions including precautionary and safety measures to be adopted.

 **Certificates**

Submit test certificates or documentation to substantiate product performance and recognised environmental safety standards.

1. **Execution**

Surface areas to receive the anti- termite treatment should be suitably levelled and compacted strictly in accordance with the manufacturer’s recommendations. A certificate from the Owner/PMC, in compliance of above is a must before the application of treatment.

 **Application**

Hand operated pressure pump shall be used for uniform spraying of the chemical. To have proper check for uniform, spraying of chemical, graduated containers shall be used. Proper check should be kept that the specified quantity of chemical is used for the required area during the operation. The whole process must be carried out in the presence of the Owner/PMC and record has to be maintained and jointly signed.

1. **Time of Application**:

Soil treatment shall start when foundation trenches and pits are ready to take base concrete in foundations. Laying of base concrete shall start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub-soil water. The foregoing applies also in the case of treatment to the filled earth surface within the plinth before laying the subgrade for the floor.

1. **Disturbance**:

The treated soil barriers shall not be disturbed after they are formed. If treated soil barriers are disturbed accidentally, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

1. **Treatment of Column-Pits, Wall-Trenches and Basement-**

 **Tanks Excavation and Similar Embedded Elements.**

1. In the case of R.C.C. framed structures with columns and plinth beams and R.C.C.basements/tanks with concrete mixes rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom of excavation for columns and plinth beams. The treatment shall start at the depth of 500mm below ground level. From this depth the back-fill around the columns, beams and R.C.C. basement wall shall be treated at the rate as per IS 6313 Part II. The other details of treatment shall be as laid down in the Clause (c) below.
2. The bottom surface and the sides (up to a height of above 300mm ) of the excavation made for column pits, wall trenches and basements shall be treated with the chemical at the rate specified in IS 6313 (1981) Part II of 1981.
3. After the column foundations and the retaining wall of the basement come up, the backfill in immediate contact with the foundation structure shall be treated at the rate specified in IS 6313 of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150mm centres close to the wall surface and spraying the chemical with the above dose. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaced of the columns and walls so that the earth in contact with this surface is well treated with the chemicals.
4. **Treatment of Top Surface of Plinth Filling**

The top surface of the filled earth within plinth wall shall be treated with chemical emulsion at the rate as per IS 6313 Part II (surface area) before the sand/subgrade is laid. Holes up to 50 to 75mm deep at 150mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

1. **Treatment of Inner Wall Surfaces**

To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, small channel 30 x 30mm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade) and rod holes made in the channel upto ground level 150mm apart and the chemical emulsion poured along the channel as per rate of application, mentioned in IS 6313 Part II (1981) so as to soak the soil right upto bottom. The soil shall be tamped back into place after this operation.

1. **Treatment Of Soil Along External Perimeter Of Building**

During progress of work, provide holes in the soil with iron rods along the external perimeter of the building at intervals of about 150mm and depth 300mm and filling these holes with chemical emulsion at the rate (as per IS 6313 Part II) per Metre of perimeter of the external wall.

1. **Treatment for Expansion Joints**:

Anti-termite treatment shall be supplemented by treating through the expansion joint after the sub-grade has been laid as per IS 6313 Part II of 1981.

1. **Treatment of Soil Surrounding and Conduits**:

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe or conduit for a distance of 150mm and to a depth of 75mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75mm for distance of over 30mm from ground level.

1. **Safety Precautions.**

All chemicals used for anti-termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect on health when absorbed through the skin, in-haled as vapours or spray mists or swallowed.

The Contractor shall take all necessary precautions as per the manufacturers safety norms and ensure for absolute safe working conditions.

Necessary masks & hand glasses shall be provided to the workers.

Guarantee

Guarantee period for the anti- termite treatment is 10 years from the date of application; an approved affidavit pertaining to it must be submitted by the Contractor.

## Specification for Sand Filling.

1. **General**

The sand filling is to be done under the floors and plinth beams or like areas. The sand filling shall be done in layers as specified in the drawing or directed by the Owner/PMC.

1. **Material**

The sand shall be evenly graded, as per the relevant IS Code unless and otherwise specified in the drawing. The sand shall be free from any foreign matter, tree roots, clay and deleterious substances.

Generally, “FINE SAND”/ PIT SAND which complies with the above standards is used for the filling purpose, unless shown otherwise in the drawing.

1. **Submittals**

The Contractor shall submit the following to the Owner/PMC for his approvals, before procuring the materials;

1. Material test report as, carried out in the laboratory in accordance with the relevant IS Code.
2. Source of material
3. **Execution**

Surfaces on which the sand filling is to be done shall be well compacted and duly certified by the Owner/PMC in writing.

Sand filling will be done in layers not exceeding 150mm or as specified in the drawing or as directed by the Owner/PMC. Each layer shall be well watered to the optimum moisture content limits, rammed and thoroughly consolidated by suitable means to achieve the desired compact layer to the satisfaction of Owner/PMC.

## Specification for Hume Pipes (Reinforced).

 Pipes: All pipes must be new and perfectly sound conforming to specifications for non-pressure pipes as laid down in IS: 456 free from cracks, cylindrical straight and of standard nominal diameter and length smooth from inside and outside. They shall be made of spun process and of approved make and shall have even texture. Each pipe shall have one collar with it.

 The pipes shall have smooth and uniform inner surface and when laid the inner projections are to be eliminated. The intended purpose is to pass services, cables, pipes etc. at later date.

## Specification for Vapour Barrier.

1. **General**

A vapour barrier as per the specification and item description shall be provided between the Lean concrete and the reinforced concrete surface to prevent the above structure from water penetration.

1. **Material**

Unless specified otherwise, a layer of 300 microns High density polyurethane sheet shall be laid over the cement plaster/ lean concrete.

1. **Submittal**

The contractor has to provide all necessary information about the material as required by the Owner/PMCs, before execution of the work.

1. **Execution**

The lean mix concrete shall be plastered with cement plaster 1:4 ( 1 cement 4 coarse sand), 12mm thickness to give a smooth even surface for laying the H.D.P.E. sheet / bituminous craft paper vapour barrier. Sheets shall be overlapped on each other 100mm and properly pasted together with an approved adhesive. It shall be ensured that no tearing or puncturing of sheet occurs on account of indiscriminate use of area by labour. In unavoidable circumstances, it shall be covered with additional layer of the sheet with 100mm overlap beyond torn area.

**SECTION D 2 – Concrete Works**

## Specifications for Earthwork and Excavation

1. **General**
2. **Description**

This section covers the requirements for furnishing of cement concrete, proportioning, batching, mixing, testing, test intervals, placing, compacting, finishing, jointing, curing and all other work as required for cast-in-place reinforced concrete.

Cement concrete shall be composed of cement, fine aggregate, coarse aggregate, water, with or without admixture as approved, proportioned and mixed as specified herein.

1. **Related Work Specified Elsewhere**
2. Steel reinforcement
3. Formwork
4. **Applicable Codes and Standards**

The codes and standards generally applicable to the work of this section are listed hereinafter.

IS : 8112 Ordinary and low heat Portland cement

IS : 383 Coarse and fine aggregates from natural sources for concrete.

IS : 455 Portland slag cement.

IS : 1489 Part I Portland pozzolana cement - Specification.

IS : 1727 Methods of Test for pozzolanic materials.

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

IS : 516 Methods of Tests for strength of concrete

IS : 1199 Method of sampling and analysis of concrete.

IS : 1200 Method of measurement of building and civil engineering work –

 Concrete work.

 IS : 1786 Specification for high strength deform steel.

IS: 1838 Performed fillers for expansion joints in concrete non-extruding and

 Resilient type.

IS: 1946 Code of practice for use of fixing devices in walls, Ceilings and floors

 of solid construction.

IS: 2386 Methods of test for aggregates for concrete (Part 1 to VIII)

IS: 2430 Methods for sampling of aggregates for concrete.

 IS: 3812 Pulverized Fuel ash – Specifications.

 IS: 2505 Concrete vibrators, immersion type

 IS: 2645 Integral cement waterproofing compounds

 IS: 2751 Recommended Practice for welding for reinforcement bars.

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

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

 concrete.

 IS: 4082 Recommendations on stacking and storage of construction materials

 at site.

 IS: 4925 Batching Plants.

 IS: 4926 Ready mixed Concrete.

 IS: 6925 Methods of test for determination of water Soluble Chlorides in

 concrete admixtures.

IS: 6491 Methods of sampling fly ash.

IS: 7861 Code of practice for extreme weather concreting.

IS: 7861 Recommended practice for hot weather (Part I) concreting.

IS: 9103 Admixtures for concrete.

IS: 10262 Recommended guide lines for concrete mixed design.

 IS: 4634 Batch type Concrete Mixers – Method of Test Performance.

 IS: 7246 Recommendations for the use of table vibrators for consolidating

 Concrete.

 IS: 12269 Specification for 53 Grade Ordinary Portland Cement.

The following clauses are intended to amplify the requirements of the reference documents listed above and the contractor shall comply with these clauses.

1. **CONCRETE TESTING SERVICE:**

The Contractor must employ and maintain a testing laboratory where he shall arrange for preliminary and routine testing to be carried out.

1. **Submittals**
2. **Detailed Bar Bending Schedule**

 The detailed bar bending schedules must be submitted to the Owner/PMC for approval before reinforcement is bent and/ or fixed.

1. **Product Data**

 Contractor shall submit manufacturer’s product data with application and installation instructions for proprietary materials and items, including admixtures, patching compounds, joint systems, and others as requested by the Owner/PMC.

1. **Material Report**
2. Prior to delivery, Contractor shall submit a certificate on materials, which complies with, specified requirements including names, sources and description of all materials for the approval by the Owner/PMC.
3. Quality Inspection Plan to ensure continuing quality control of ingredients by periodic sampling, testing and reporting to the Owner/PMC on the quality of materials being supplied.
4. **Mix Design**

 The contractor shall design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements specified.

 Prior to commencement of concrete work the contractor shall submit the mix design as a report for the approval of Owner/PMC. This report shall compare the proposed mix design with specified requirements and shall be summarised on form.

1. **Plant and Equipment**

 The contractor shall submit the following to the Owner/PMC well in advance:

 The proposed program, methods and details of plant and equipment to be used in testing ingredients, mix design and concrete samples.

 The proposed program, methods and details of plant and equipment to be used for batching and mixing of concrete, as well as placing the concrete at any height.

1. **Reports for Inspection and Testing**

 During concreting operations, the contractor shall conduct inspection and testing as described in the relevant subsection and all reports thereon shall be submitted in summary form to the Owner/PMC at periodic intervals and when requested.

1. **Schedules**

 The contractor shall prepare working schedules for dates and rate of placing of concrete for each item of work and submit it to the Owner/PMC when requested.

1. **Materials**

 Before bringing to the site, all approved samples shall be deposited in the office of the Owner/PMC before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their approved samples. Fresh samples shall be deposited with the Owner/PMC whenever type or source of any material changes. The contractor shall check each fresh consignment of materials as it is brought on the works to ensure that they conform to the specifications and / or approved samples.

 The Owner/PMC shall have the option to have any of the materials tested to find whether they are in accordance with specifications. All bill vouchers and test certificates which in the opinion of the Owner/PMC are necessary to convince him as to the quality of materials or their suitability shall be produced for his inspection when required.

 Any materials, which have not been found to conform to the specifications and not approved by the Owner/PMC shall be rejected forthwith and shall be removed from the site by the contractor at his own cost within 48 hrs. or within the time stipulated by the Owner/PMC. The Owner/PMC shall have the power to cause the contractor to purchase and use materials from any particular source which in his opinion may be necessary for the proper execution of work.

1. **Cement**

The Cement used shall be one of the following types: -

Ordinary Portland Cement conforming to IS: 1489, IS: 8112, IS: 12269.

Whenever possible all cements of each type shall be obtained each from one consistent source throughout the contract. "Cement of different types shall not be mixed one with the other. Different brands of cement, or the same brand of cement from different sources, shall not be used without prior notification and approval."

All cement shall be fresh when delivered and at ambient atmospheric temperature.

Cement shall be used in rotation of delivery. Cement, which in the opinion of the Owner/PMC, has deteriorated, shall not be used. All batches of cement in which unacceptable material has been mixed with acceptable material shall be rejected and shall be removed from the site forthwith. Cement from broken bags shall not be used in permanent works.

The contractor shall provide facilities for making 7 days tests from time to time in accordance with IS : 3535, IS : 4031 and IS : 4032 and shall allow for carry out such tests as may be required by the Owner/PMC and for reporting the results.

For Plain concrete, mortars and structural concrete up to Grade M25 either PPC or fly ash blended 43 grade OPC cement shall be used.

 For structural concrete above M25 PPC or fly ash blended with 53 grade OPC cement shall be used.

In above both cases maximum percentage of fly ash in site blending shall be 25%.

PPC and fly ash blending at site shall conform to IS 1489 part 1 and part 2

1. **Aggregates**

**Material:**

Aggregates from natural sources shall be in accordance with IS: 383. The aggregate shall be clean, hard, durable and shall not contain iron pyrites, iron oxides (other than magnetite), mica, shale, coal or other laminar, soft or porous materials.

For fair-faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities, which may cause discoloration.

**Submittals**:

The contractor shall submit to the Owner/PMC certificates of grading and compliance from the suppliers for all consignments of aggregate.

 **Quality Assurance:**

In addition at site from time to time, the contractor shall test that aggregates in accordance with IS: 2386 Parts I, II and III. The contractor shall allow for and provide all necessary apparatus for carrying out each test and for supplying test records to the Owner/PMC.

**Storage:**

The aggregate shall be processed, stored handled and batched in acceptable clean areas on dense concrete or dense bituminous surfaces in bunkers so as to prevent physical or chemical contamination, to preserve the gradation and to ensure good drainage. Aggregate shall be covered at all times to protect material from adverse climatic conditions.

**Fine Aggregates:**

The fine aggregate shall be pit sand, stone dust or may comprise a combination of these two which separately meet the requirements of this specification when separately batched or other approved sand. It shall be free from clay, loam, earth or vegetable matter and from salt or other harmful chemical impurities. It shall be clean, sharp, strong, angular and composed of hard siliceous material.

Natural sand and crushed stone shall not contain more than 0.10%, subject to the overall requirement that the maximum chlorides content of the concrete expressed as a percentage of chloride ions by weight of cement shall not exceed 0.3 % when ordinary Portland cement is used and 0.2 % when sulphate resisting cement is used.

Natural sand and crushed stone sand will not contain 0.40 % of total acid soluble sulphate when expressed as sulphur trioxide by weight of oven dry sample.

Crushed stone sand shall not contain appreciable amounts of flaky or elongated particles.

 **Silt content in fine aggregate:**

 Silt is defined as the particles passing through I.S. sieve of 0.075mm. size, and its particle size is less than 0.06 mm. Being smaller particles they have a large specific surface area. Silt may be organic or inorganic. Organic silt combines chemically with the cement and harms the strength of the concrete. Inorganic silt may be inert. Even if the silt considered inert it is harmful for the cement concrete as silt requires more water due to its more specific surface area and more water is needed to maintain the same workability resulting in more water / cement ratio thus reducing the strength of the concrete.

 The maximum quantity of silt as determined by the method prescribed in IS: 2386 Part II shall not exceed 8%.

 Stone dust shall be obtained by crushing hard stone and the grading as determined by the method prescribed in IS: 2386 Part I shall be within the limits of Grading Zone III given in Table 1. When the grading falls outside the percentage limits given for the sieves other than 600 micron and 300 micron (I.S) sieves by not more than 5 percent and on 150 micron sieve by not more than 20 percent it shall be regarded as following within this zone. The 5 percent can be summation on one or more sieves.

  **Fly Ash:** Fly ash is a finely divided residue that results from the combustion of ground or powdered coal and that is transported by flue gasses. Fly ash is the most widely used pozzolanic material. Depending on the quality of fly ash and the amount of cement replaced water can be reduced by 20%, which adds benefit towards higher strength and better durability. Fine particles of fly ash get adsorbed on the oppositely charged surfaces of the cement particles and prevent them from flocculation. The cement particles are dispersed and do not trap large amounts of water, thus reducing water requirement for the same consistency. Effective packing of various size and shape particles of combined fly ash and cement reduces water demand to plasticize the system. This water reduction due to the fly ash reduces drying shrinkage in concrete.

**Coarse Aggregate**

 The coarse aggregate shall be crushed stone or approved pee gravel.

 Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable, clean and free from soft, friable, thin, flat, elongated or flaky pieces.

 The water absorption value shall not exceed 2.5% by weight, when determined in accordance with the relevant IS Code. The flakiness and elongation indices of the predominant fractions in the single- sized coarse aggregates shall not exceed 20% and 35% respectively when determined in accordance with the relevant IS Code.

 The aggregate impact value for coarse aggregate shall not exceed 30% when determined in accordance with the relevant IS Code

 Coarse aggregate shall not contain more than 0.03% by weight expressed as a % of chloride ion when tested subject to total chloride content arising from all ingredients in a mix including cement, water and admixtures expressed as percentage of weight of cement in the mix shall not exceed 0.2% in case of sulphate resistant cement and 0.3% in case of Ordinary Portland Cement.

 Coarse aggregate shall not contain more than 0.04% total acid soluble sulphates when expressed as sulphur trioxide by weight of oven dry sample.

 Pee gravel shall be rounded sound, hard, clean, non-porous, suitably graded in size with or without broken fragments and free from flat particles of shale, clay, slit, loan and other impurities.

 Except where it can be shown to the satisfaction of the Owner/PMC that a supply of properly graded aggregate of uniform quality can be maintained over the period of the works, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in correct proportions as and when required.

 The maximum size of coarse aggregate shall be such that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of formwork.

1. **Water**

 Water used in the works shall be potable water and free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and / or washing aggregate shall be fresh and clean, free from injurious oil, salts, acids, alkali, other chemicals and organic matter.

 Water shall be from the source approved by the Owner/PMC and shall be in accordance with IS : 456.

 Water storage shall be in an enclosed tank protected from air borne contamination and direct sunshine by suitable screens and insulation.

 Where the Contractor proposes to control the temperature of the water used in the works by the addition of ice, the ice shall be produced from water complying with this specification.

 Water containing unmelted ice shall not be used for producing concrete.

1. **Admixtures and Additives**

 Chemical admixtures are not to be used until permitted by the Owner/PMC. In case their use is permitted, the type, amount and method of use of any admixture proposed by the contractor along with the manufacturer’s catalogue/data shall be submitted to the Owner/PMC for approval.

 The contractor shall further provide the following information concerning each admixture to the Owner/PMC.

a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.

b) The chemical names of the main ingredients in the admixture.

c) The chloride iron content, if any, expressed as a percentage by weight of admixture.

d) Whether or not the admixture leads to the entrainment of air when used in the manufacturer's recommended dosage.

e) Where two or more admixtures are proposed to be used in any one mix, the manufacturer's written confirmation of their compatibility.

 In reinforced concrete, the chloride content of any admixture used shall not exceed 2 percent by weight of the admixture as determined in accordance with IS : 6925 and the total chloride content in all admixtures used in concrete mix shall not exceed 0.03 percent by weight of cement.

 The admixtures when used shall conform to IS: 9103. "The suitability of all admixtures shall be verified by trial mixes".

 The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.

 Retarding admixtures when used shall be based on lignosulphonates with due consideration to IS : 7861.

 Waterproofing admixtures shall comply with IS: 2645.

 The testing of the type of admixture, the Contractor proposes to use, shall be done by any independent laboratory chosen by the Owner/PMC

 Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer’s specifications stating the quantity of water proofing material in litres or kg per 50 kg of cement and will be paid for separately.

1. **Related Materials**
2. Spacers shall be of such materials and designs as will be durable.
3. Concrete spacer block shall be factory made. Concrete spacer block made on the construction site shall not be used.
4. Sample concrete spacer block shall be submitted to the Owner/PMC for approval at least 21 days before it is intended to place concrete.
5. Plastic spacers shall be sufficiently rigid not to distort unacceptably under applied loads and shall be so perforated s to ensure a continuity of concrete through the spacer. Samples of spacers shall be submitted for approval at least 21 days before it is intended to place concrete.
6. **Plant**

 The contractor shall obtain the approval of the Owner/PMC for all plant items which he proposes to use for the manufacture and placing of concrete.

 The arrangement and setting of plant for manufacture of concrete shall be agreed with the Owner/PMC.

 The contractor shall maintain all items of plant at all times in a clean and efficient working condition. A related periodic report in the approved Performa shall be submitted to the Owner/PMC during the contract execution period. Preventive maintenance shall be programmed well in advance and the Projects Manager informed. Downtime of more than 24 hrs shall not be acceptable.

1. **Storage**

 All goods and products including owners supply covered by these specifications shall be procured well in advance and stored as specified below:

1. **Cement**

 Cement shall be stored on a raised floor in dry weather proof and drought free but well ventilated shed.

 Cement bags shall be stacked close together away from external walls and in stacks of not more than ten bags to avoid lumping under pressure.

 Cement stored during monsoons or cement expected to be in store for more than eight weeks shall be completely enclosed in 700 gauge polythene sheet so arranged that the flap closes on the top stack. The contractor shall ensure that protective polythene sheet is not damaged at any time during use.

 Cement of different types shall be stored in separate sheds or separate compartment of a shed. If different types of cement are mixed, the Owner/PMC will have the discretion to condemn all the cement concerned.

 Consignments of cement shall be used in order of delivery. A record shall be kept of the batch numbers of cement deliveries in such a form that the part of the works in which the cement is used can be readily identified. If during delivery or by test, the cement is found to be defective, the same shall be returned back to owner, forthwith.

 The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.

 Cement stored on site for a period longer than eight weeks shall be tested to the satisfaction of the Owner/PMC before it is used in the works.

 Cement, which has so deteriorated in quality that it no longer conforms in all respects to the requirements of this specification, will be condemned by the Owner/PMC and shall not be used in the works. The contractor shall immediately remove from the site all cement that has been so condemned.

1. **Aggregates**

 Aggregates shall be stored on a suitable well-drained raft of concrete, timber, metal or other approved material. The storage of aggregates on the ground will not be permitted.

 Each size of aggregates shall be stored separately in such a manner as to prevent spillage and mixing of one aggregate with an adjacent aggregate. The dividing walls of any bin shall be of sufficient height and the aggregate shall be so deposited that a distance of 100 mm shall be left between the top of the division wall and any part of the aggregate stack.

 When stack pilling, the aggregate shall not form pyramids resulting in segregation of different size particles. The stacks shall be regular and of height not exceeding two meters.

1. **Concrete Mix Proportions**

 Cement concrete used in the works shall be either of the two categories given below: -

1. **Ordinary Concrete**

 All cement concrete not designated by strength shall be treated as ordinary concrete of nominal mix as specified. The aggregates and cement shall be specified. The aggregates and cement shall be measured by volume. Mixing water shall be measured in graduated litre cans.

1. **Controlled Concrete.**

 All cement concrete designated by strength shall be treated as controlled concrete. The controlled concrete shall conform to one of the grades specified herein or on the drawings. The aggregates and cement shall be weight in approved weight batching equipment. Mixing water shall be measured in graduated litre cans. One or more complete bags of cement shall be used for each batch of concrete.

 The controlled concrete shall meet with the strength requirement laid down in codal provisions.

 The contractor shall be responsible for designing mixes of the specified performance to suit the degree of workability and characteristic strength required for the various parts of the works.

 Alternative mixes may be designed by the contractor for use in both thin and narrow sections and thick sections. Special mixes using finer aggregates may be designed by him for infilling pockets and narrow spaces and for regions of congested reinforcement.

1. **Brick Bat Concrete.**

 Brick Aggregate shall be obtained by breaking well burnt or over burnt dense bricks/brick bats. They shall be homogeneous in texture, roughly cubical in shape and clean. They shall be free from un-burnt clay particles, soluble salt, silt, adherent coating of soil, vegetable matter and other deleterious substances. Such aggregate should not contain more than 1% of sulphate and should not absorb more than 10% of their own marks of water when used in cement concrete. It shall conform to IS: 306 - 1986 unless otherwise specified. The mixing and laying shall be as per cement concrete mentioned above.

1. **Water Cement Ratio**

 The quantity of water added to the cement and aggregates during mixing shall be such as to produce a concrete having sufficient workability to enable it to be properly compacted to be worked into the corners of the shuttering and around reinforcement.

 Due account shall be taken of the variation of moisture content, within any consignment of aggregate and any variations due to watering, exposure to rain or drying weather. The contractor shall carryout regular moisture content tests in accordance with IS: 2386 Part III on stacked aggregates as directed by the Owner/PMC and results submitted to him.

 In case of ordinary concrete the maximum value of water cement ratio shall be 0.50 but preferably be 0.45 and in the case of controlled concrete the water cement ratio is determined by the mix design from the approved NABL lab from Owner/PMC and shall also comply with the relevant provisions of IS: 456.

1. **Test Cubes**

 The strength of concrete either in assessing the suitability of the trial mixes or when placed in the works shall be determined from 150 mm cubes made, cured, stored, transported and tested in accordance with IS:516. Test cubes shall be made as, where and when the Owner/PMC may require.

 Test cubes shall be made under the direct supervision of the competent person appointed by the contractor to supervise all stages of the preparation and placing of concrete. They shall be made by the contractor in the presence of the Owner/PMC generally from concrete taken at the point of discharge from the mixer and the contractor shall provide suitable facilities in the form of a hut or other covered protection as agreed with or directed by the Owner/PMC for the storing and curing of the test cubes during the first 24 hours after making them and until they are dispatched to the testing laboratory.

 Test cubes shall be marked and dated in such a manner that the grade and the part of the works in which the concrete they represent, has been placed, can be readily identified.

 Testing shall be done in an approved laboratory at the site itself and the results shall be submitted promptly by the contractor to the Owner/PMC.

1. **Works Tests**

 When concrete of a particular grade is first used in the works, 2 cubes each shall be taken from 3 separate batches during each of the first 7 days of using that grade. Of these 6 cubes made daily, 3 cubes (each cube representing concrete made of a different batch) shall be tested at 7 days and the remaining 3 cubes shall be tested at 28 days. For every subsequent 20 m3 of concrete or for every day's concreting be the less in volume, 6 cubes shall be made for each grade of concrete and tested at 7 and 28 days as above.

 **Dry Shrinkage:** Dry Shrinkage test shall be as per IS 516

 **Chemical Analysis:** Sampling and testing requirements to be as per IS 516

 If the mean concrete strength determined from such 28-day cube tests does not reach the characteristic strength for that grade, the materials and / or their proportions for that grade shall be modified by the contractor to the satisfaction of the Owner/PMC.

 In addition the contractor shall at his own expense take such actions, as the Owner/PMC may consider necessary on the concrete placed in the part of the works represented by the set of cubes so

1. **Concrete Mixing**

 All concrete, whether ordinary or controlled shall be mixed in an approved mixer for the minimum time necessary to ensure adequate quality and uniform distribution of the materials. The cement and aggregates shall normally be first mixed dry until all particles of aggregate are coated with cement after which the water shall be added.

 Allowance shall be made for the moisture content of the sand added for each mix.

 The temperature of the aggregate, water and cement when added to the mixer shall be such that the temperature of the concrete at the time of placement is less than 40oC.

 Materials for concrete shall be deposited into the drum while it is in rotation. Mixers shall not be loaded beyond their rated capacity and each batch shall be completely discharged from the drum before recharging takes place.

 Facilities shall be provided to spray the mixer drum with cool water between batches and on the completion of concreting the drum shall be washed down. The surface of the mixer drum shall be maintained in a clean condition at all times.

 Re-tampering and / or mixing of concrete, which has partially hardened and set, will not be permitted under any circumstances.

1. **ACCEPTANCE CRITERIA**

 The acceptance standards for works represented by various tests shall be deemed to have been attained if the results comply with the relevant IS code or standards as approved by the Owner/PMC in writing.

1. **Defective Works**

 Should test results, which do not comply with the specification, be obtained during the progress of the work the structural work represented by such tests shall be regarded as un-acceptable. The Owner/PMC may permit postponement of demolition and reconstruction, should the Contractor submits to consider the results of further test selected by the Owner/PMC From the followings:

1. Loading tests to a specification prepared by the Owner/PMC.
2. Compressive Strength tests on cores cut from the work at positions determined by the Owner/PMC.
3. Chemical Analysis of samples cut from the work at position determined by the Owner/PMC.
4. Such other tests as may be approved by the Owner/PMC.

Such additional tests, demolitions, reconstruction, modifications as approved by the Owner/PMC shall be carried out by the Contractor without any claim for extra costs/ time.

1. **Records**

In addition, the Contractor shall keep in record and send to the Owner/PMC in a required Performa, the following information for every cube tested. This is in addition to the information required by IS: 516

1. Date of Casting
2. Date of receipt of cubes in the laboratory
3. Mix and/ or Concrete Quality
4. Slump
5. Section of work represented by test cube, pour location of sampled concrete

One cube shall be tested at 7 days and one at 28 days.

1. **Transporting**

The period between mixing the concrete and placing it in the final position shall be kept to a minimum and the delivery of concrete shall be co-ordinated with the rate of placement to avoid delays in delivery and placement. Concrete shall be handled from the place of mixing to the place of final deposit by methods, which prevent segregation, loss of ingredients and contamination and maintain the required workability. Use of transit mixers of adequate capacity is intended. Concrete pump location with respect to placement shall be got approved prior to commencing the mixing.

Should any segregation have occurred in any batches arriving at the place of deposition, such batches shall be deposited and thoroughly turned over by hand before placing in the works. Where concrete is conveyed by chutes, the chutes shall be made of metal or fitted with metal linings. The approval of the Owner/PMC shall be obtained for the use of chutes in excess of 3 meters long and in such cases the concrete shall be remixed if so required by the Owner/PMC.

All plant and equipment used in the transportation of concrete shall be thoroughly cleaned before and after each working period and at all changes of concrete mixes. Water used for this purpose shall be discharged well clear place.

1. **Preparation Before Concreting**

The inside surface of the forms against which concrete is to be placed shall be clean and free from dried or hardened spattering or coatings of concrete. The forms shall be well wetted before placing concrete.

When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean, thoroughly wetted and covered with 12 mm layer of freshly mixed mortar composed of cement and sand (in the same ratio as the cement and sand in the concrete mix) immediately before placing of concrete.

 **Before any concrete is placed on the sub grade, the sub grade shall be checked and approved for degree of compaction and alignment. The sub grade shall be kept damp ahead of concreting.** Concrete shall not be placed in the works until the Owner/PMC has inspected the formwork, reinforcement, inserts and sleeves if any and given his permission to place concrete by signing prescribed "POURCARD". In case multiple agencies are involved in placing the inserts / services, building contractor / civil works agency shall be responsible to obtain sign – off on the pour card for proper and non-dislodge able insert / sleeves.

1. **Placing**

 Concreting of any portion of the works shall be done only in the presence of the representatives of the Owner/PMC. Concreting shall be carried out continuously always against shuttered surfaces between construction, contraction or expansion joints shown on the drawings or agreed by Owner/PMC. The contractor shall closely follow the sequence of concreting where such is specified on the drawings. If concreting is interrupted before reaching the predetermined joint an approved construction joint shall be provided.

 Immediately before placing of concrete for columns and walls, the reinforcement within and the old concrete at the bottom of the formwork shall be given a coating of cement sand mortar of the identical materials and proportions to be used in the subsequent concrete, to prevent the loss of fine material from the initial concrete pour.

 Concrete shall be deposited as nearly as is practicable to its final position and shall not be dumped in a large quantity at any point to be run or worked along the formwork manually or with vibrators. Concrete shall not be deposited at a faster rate than it can be placed and compacted.

 Concrete shall be thoroughly worked into the forms so that they are entirely filled; reinforcing bars adequately and tightly surrounded and entrained air released from the mass of concrete. Placing shall be carried out by hand prodding as well as vibrators in a manner directed by the Owner/PMC.

 The concrete shall be placed in layers not greater than 450 mm thickness and thoroughly compacted before succeeding layers are placed. Concrete shall be placed in a single operation to the full thickness of slabs, beams and similar members. No concrete shall be placed on concrete which has set sufficiently to cause the formation of planes of weakness and where these are likely to occur due to unforeseen circumstances the procedure to be followed shall be as for clause 1.16 of this specification. During concreting, care shall be taken to see that position of insert / embedment is not disturbed.

1. **Compaction**

 Each layer of concrete while being deposited shall be compacted by approved methods to form a dense material with all surfaces free from honeycombing, air holes or other blemishes.

 The contractor shall use mechanical vibration for all concrete and shall take care that internal vibrators shall not be brought into contact with the reinforcement or the formwork. Where external vibration of the forms is not adopted for fairfaced surfaces, the concrete shall be rodded adjacent to such surfaces in addition to internal vibrating.

 An adequate number of vibrators shall be used to ensure that compaction of concrete of concrete is achieved within 10 minutes of placing. Particular attention shall be given to the compaction of the concrete around the water bars to ensure that no voids or porous areas are left.

 Compacting shall cease as soon as excess water appears on the face of concrete. Any water accumulating on the surface of newly placed concrete shall be removed by approved methods and no further concrete shall be placed thereon until such water has been removed.

 Notwithstanding the requirements regarding mix design, should it be found that the proportion of water in the mix is such that laitance forms before compaction (i.e. completion of expulsion of air) is complete, the quantity of water in the mix shall be reduced. No water shall be added to concrete after mixing has been completed, but where the proportion of water in the mix is such that it is impossible to achieve complete compaction, the quantities of aggregate shall be reduced without any alteration to the quantities of cement and water. Whenever either of the aforesaid procedures is to be adopted, an additional set of 6 cubes for testing at 7 or 28 days shall be made from the adjusted mix.

 The time elapsing between the discharge of the concrete from the mixer and the completion of compaction shall not exceed 30 minutes.

 A sufficient number of spare vibrators shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

1. **FINISHES**

 All concrete surfaces shall have a good, dense finish. Except for slabs, the exposed faces of concrete for which formwork is not provided shall be smoothed with a steel or wooden trowel to provide a finish equal to that face where formwork is provided.

 The top surfaces of all floor and roof slabs specified as smooth shall be levelled and trawled before the concrete begins to set to a smooth finish at the levels of floors shown on the drawings. The trawling shall be done at such a time and in such a manner that an excess of mortar is not brought to the surfaces of concrete nor the aggregate displaced. The top surfaces of concrete slabs specified to receive an integral finish should be uniformly roughened by deep hacking before the finish is laid.

 Immediately after striking the formwork and removing any superficial water, honeycombed areas in normal unfinished concrete shall be inspected by the Owner/PMC and where directed the contractor shall immediately make good at his own expense such honeycombing while the concrete is still green to the satisfaction of the Owner/PMC. All air holes shall be similarly filled in.

 The contractor shall be responsible for providing an adequate key in concrete where plastering or rendering is specified to be applied. Hacking of the concrete surface immediately after striking the formwork will be permitted.

 The faces of all fair faced concrete shall be of even colour throughout, free from air bubbles, cracks, honeycombing or other blemishes and will be inspected by the Owner/PMC immediately after the formwork has been struck. Such faces shall not be rubbed down after striking the formwork to remove fins, efflorescence or any similar imperfections without the prior permission of the Owner/PMC.

 Concrete surface finishes shall be according to the requirements and all instructions by the Owner/PMC with regard to the method of achieving such finishes shall be implemented.

1. **Curing And Protecting**

1.20.1 Walling on concrete shall not be permitted for at least 24 hours after it has been placed in position, or for such additional length of time as Owner/PMC may direct. Immediately after compaction and completion of any surface finishes, the concrete shall be protected from the evaporation of moisture/ premature drying out by means of polythene sheeting, wet cession or other similar material kept soaked by spraying. As soon as the concrete has attained a degree of hardening sufficient to withstand surface damage, moist curing shall be implemented and maintained for a period of at least 15days after casting.

Method of curing and their duration shall be such that the concrete will have satisfactory durability and strength and members will suffer a minimum distortion, be free from excessive efflorescence and will not cause, by its shrinkage, undue cracking in the works.

Curing of concrete shall be achieved by the application of an acceptable proprietary curing agent properly applied to all exposed concrete surfaces within 30minutes of casting or removing formwork and then immediately covering the surface with a double layer of hessian.

Concrete in beams haunches shall be covered with two layer of hessian tied down so that drying winds are excluded from the surfaces. All hessian shall be kept continuously wet with water complying with this specification from the time of fixing throughout the curing period.

Nominal Curing Period: Seven days is the minimum curing period for all cast in place concrete under normal weather conditions (temperature around 25 to 27 deg.C. and normal wind speed.

This period shall be extended to a minimum of 10 to 14 days under hot weather or drying wind conditions.

The top surfaces of slabs and other horizontal surfaces shall be cured by impounding water in cement mortar bunds. Steeply sloping and vertical formed surfaces shall be kept completely and continuously moist prior to and during the striking of formwork by applying water to the top surfaces and allowing it to pass down between the formwork and the concrete.

The contractor shall give careful consideration to the curing methods and conditions for fair faced concrete. Components, which are specified to have exposed concrete finish, shall receive the same curing treatment. Moreover water used for curing shall be clean so as not to discolour the concrete.

1.20.2 All fair faced concrete shall be protected against damage from the time of striking the formwork. All edges and surfaces of such concrete shall be protected from chipping using notched timber corner pieces or other suitable covers, which shall be maintained, in place until the completion of the works.

The contractor shall be responsible for ensuring all fair faced concrete free of stains from concrete materials and shall clean all such staining as may occur at his own cost as soon as possible to the satisfaction of the Owner/PMC.

**1.20.3 Shore and Supports**

The Contractor shall not place loads on any part of structure in excess of those for which it is designed without the prior written approval of the Owner/PMC.

Temporary loads imposed by new construction at upper levels shall be carried down by adequate propping to lower levels of construction which have attained the 28 days strength and which are designed for equivalent loadings. Where this requirement necessitates the distribution of the temporary load between two or more levels of construction, adequate re- propping with suitable and approved materials at the soffits of slab, beams shall be provided after removal of the form wok and props at the lower levels and shall be maintained undisturbed until the new construction at the upper level has attained it’s specified 28 days strength.

The Contractor shall submit to the Owner/PMC full details of any supports, which he proposes to leave permanently embedded in the concrete, and shall obtain prior approval in writing before proceeding with the work.

**1.20.4 Hot Weather Concreting**

When the shade temperature is 400 C or above the contractor shall employ all necessary precautions for proper concrete placement and curing as laid down below, or else, make arrangements for concreting during evening and night hours, subject to approval of Owner/PMC.

Concreting during extreme (hot or cold) weather shall be done as per IS: 7861 part 1 & 2 with the following specifications over ruling the IS: 7861 Part 1 & 2. In very hot weather, precaution shall be taken to see that the temperature of wet concrete does not exceed 300 C while placing.

1. **HOT WEATHER CONCRETING PREPARATION**

Well in advance of concreting, preparation shall be done with necessary equipment and materials as under ample water supply for curing and sprinkling over sub-grades, wood forms, reinforcing steel, aggregates etc.

1. **SCHEDULING**

The work shall be scheduled so that concrete is placed in position with least delay.

During extremely hot periods, concreting work shall be started in the afternoon to take advantage of lower evening temperature and wind.

1. **COOLING OF MATERIALS**

All materials used for concreting shall be kept cool at the temperature specified in IS:

7861 by storing them in shade wherever possible, sprinkling coarse aggregate with water

and protecting water supply from direct sun rays. Mixing water shall be chilled in very

hot weather by refrigeration or by using ice as part of mixing water. The ice should be

melted by the time the concrete is discharged from the mixer.

1. **MOISTENINGS**

For concrete on ground, the sub-grade shall be dampened the evening before the concreting. However prior to placing concrete there should be no standing water or puddles on the sub-grade. Reinforcing steel and wood forms shall be thoroughly moistened just before placing concrete.

1. **TEMPORARY COVERS**

Immediately after the concrete is placed, vibrated and leveled temporary covers such as burlap shall be placed over the fresh concrete and kept continuously wet when ready for floating and/or final finish, uncover only a small section immediately ahead of the finishing cover again at once after final finish and keep the cover wet.

1. **PROTECTION FROM WIND AND SUN**

When high winds also prevail along with hot weather, the fresh concrete shall be protected by placing a wind breaker on the windward side of hot days. The concrete shall be protected from direct sunlight by erecting a sunshade or by taking advantage of the shade from nearby buildings or trees if any.

1. **CURING**

As soon as the concrete surface is hard enough to resist marring curing shall be started kept covered with polyethylene film, water proof paper, or water holding materials such as straw, or burlap or by spraying or a curing compound. If curing compound is used it should be applied after final finishing care should be taken that adequate and uniform coverage is obtained. The concrete surface shall be kept constantly wet. The curing shall be continued for a specified number of days.

1. **RECORDING WEATHER CONDITIONS**

Weather conditions like humidity, temperature wind and clouds shall be recorded and made a part of the permanent job record.

1. **TESTING SPECIMENS**

In hot weather it is absolutely necessary that sampling making and curing of test specimens shall be done strictly in conformity with standard specifications. Test cubes shall definitely be kept damp and under a shed. They must receive continuous standard moist work until tested.

## Concrete Joints

1. **Construction Joints**

**General**

Construction joints shall be made only where shown on the drawings

**Submittals**

Where the contractor wishes to form joints in concrete other than those shown on the drawings, he shall submit his proposals giving the position, form and treatment of such joints to the Owner/PMC for his approval.

**Locations**

Generally for suspended slabs, the construction joint shall be located within the middle third of their span, or along and over the line of supporting beams or walls and at a distance from their edge acceptable to the Owner/PMC.

For beams, the construction joint shall be located vertically but not nearer to the support less than the one-third point.

For joints between the tops of columns or walls and slab or beam soffits shall be located within 12mm of the soffit.

**Execution**

Vertical construction joints shall be formed against a stop board and horizontal construction joints shall be level. Except where shown otherwise on the drawings, reinforcement shall continue through construction joints.

As soon as possible after the formwork has been struck for vertical joints or after the concrete has set in horizontal joints, the surface laitance of the hardened concrete on the face of the joint shall be removed to expose the coarse aggregate in such a manner that the loosened particles of aggregate and damaged concrete are not left on the surface. The exposed face shall be swept clean of foreign matter and laitance. Feathered construction joints will not be permitted. Immediately before placing the new concrete, neat cement grout shall be poured over the old concrete followed for horizontal joints by a 12 mm thickness of sand cement mortar of the same materials and proportions to be used in the new concrete.

**Starter plinths** to wall, column and other vertical members shall have a height of not less than 100mm above structural floor level except where otherwise shown on the drawing.

## Contraction Joints

 Contraction joints required will be as shown on the drawings. Contraction joints shall not be hacked, wetted or mortared before concrete is placed against them.

## Expansion Joints

1. **General**

 Expansion joints shall be provided where shown on the drawings or as directed by Owner/PMC. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings.

 The contractor shall ensure that no debris is allowed to enter expansion joints. Expansion joints shall be provided with joint filler, a joint sealing compound and in waterproof concrete, a water bar.

1. **Open Joint Fillers**

 Where shown on the drawings, open joints in the structure shall be filled with joint fillers. The joint filler shall be easily and uniformly compressible to its original thickness, easily cut or sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water and free of any constituent, which will bleed into or stain the concrete. The joint filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling and placing to permit the formation of straight joints.

1. **Joint Sealing Compounds**

 Joint sealing compounds shall seal joints in concrete against the passage of water, prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete surfaces and shall be resistant to flow and weathering.

 A Poly-sulphide joints where specified on the drawings shall be sealed with polysulphide liquid polymer, stored, mixed, handled, applied and cured strictly in accordance with the manufacturer's written instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer strictly in accordance with the manufacturers written instructions prior to sealing. The contractor shall use only competent personnel experienced in the application of polysulphide for such work.

 Where specified in the drawings, rubber / bituminous based sealants shall be of an approved manufacturer. The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer's written instructions.

1. **Water bars**

 Where water bars are shown on the drawings, the joints shall incorporate an approved PVC external type water bar complete with all necessary moulded or prefabricated intersection pieces assembled in accordance with the drawings with bends and butt joints in running lengths made by heat welding in an electrically heated jig.

 Jointing and fixing of water bars shall be carried out strictly in accordance with the manufacturer's written instructions.

 The water bars shall be installed so that they are securely held in their correct position during the placing and compacting of the concrete.

 Where reinforcement is present adjacent to water bars, adequate clearance shall be left between the reinforcement and water bars to facilitate compaction of the concrete. Double headed nails may be used in the edge of the water bar outside the line of the external grooves for fixing purposes, but no other holes shall be permitted through the water bar.

## Inserts

 The contractors shall fix all necessary inserts such as steel plates, pipe sleeves, bolts etc. and make provision of holes, pockets, dowels etc. in the formwork to enable subsequent fixing of supports, brackets, ceilings, precast members etc. as indicated on the drawings, called for in the schedule of items or as required by the Owner/PMC. Nothing extra over and above the provision as per the schedule of items shall be paid to the contractor on the account.With the prior agreement of the Owner/PMC, expansion type fasteners may be used by the contractor in hardened concrete.

 **CRACKS**If any cracks develop in the reinforcement cement concrete construction which in the opinion of the Owner/PMC may be detrimental in strength of the construction, the contractor at his own expense shall test the structural element in question. If under these test loads the cracks shall develop further the contractor at his own expense shall dismantle the construction, cart away the debris, replace the construction and carryout all consequential work there to at no extra cost.If the cracks are not detrimental to the stability of the construction in the opinion of the Owner/PMC, the contractor at his own expense shall grout the cracks with pneumatically applied mortar, mixed with epoxy type bonding agents to produce repair materials with strength, durability and elasticity characteristics compatible with the parent material being repaired. As his own expense and risk he shall also make good all other building works such as plaster, moulding, surface finish of floors, roofs, ceiling etc. which in the opinion of the Owner/PMC have suffered damage either in appearance or stability owing to such cracks.In no circumstances, the Contractor must not start/ proceed with the repair works on the adversely affected concrete surfaces until and unless this is reviewed and permitted by the Owner/PMC.The repair work shall be carried out to the satisfaction of the Owner/PMC. The decision of the Owner/PMC as to the extent of the liability of the contractor in the above matter shall be final and binding on the contractor.

## Load Testing On Completed Structures

 During the period of construction or within the defect liability period the Owner/PMC may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons: -

* 1. Results of compressive strength on concrete test cubes falling below the specified strength.
	2. Premature removal of formwork
	3. Inadequate curing of concrete
	4. Over loading during the construction of the structure or part thereof
	5. Carrying out concreting of any portion without prior approval of the Owner/PMC.
	6. Honey combed or damaged concrete, which in the opinion of the Owner/PMC is weak and will adversely affect the stability of the structure to carry the design load, particularly important or critical areas of the structure.
	7. Any other circumstances attributable to alleged negligence of the contractor, which in the opinion of the Owner/PMC may result in the structure or any part thereof being of less than the expected designed strength.

 All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Owner/PMC. Such tests should be carried out only after expiry of minimum 28 days or such longer period as directed by the Owner/PMC.

 The structure should be subjected to a super-imposed load equal to 1.25 times the specified superimposed load assumed in the design. This load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members as directed.

 The deflection due to the superimposed load shall be recorded by sufficient number of approved deflect meters capable of reading unto 1/50of a mm and located suitably under the structure as directed by the Owner/PMC. If within 24 hours of the removal of the superimposed load, the structure does not recover at least 75% of the deflection under the superimposed load, the test loading shall be repeated after a lapse of 72 hours. If the recovery after the second test is less than 80% of the maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

 In such cases the part of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Owner/PMC. However such remedial measures shall be carried out to the complete satisfaction of the Owner/PMC.

 All costs involved in carrying out the tests and other incidental expenses there to shall be borne by the contractor regardless of the results of the tests. The contractor shall take down cut-out and reconstruct the defective work or shall make the remedial measures instructed at his own cost, if there are any lapses on the part of the contractor.

 In addition to the above listed tests, non-destructive tests methods such as core test and ultrasonic pulse velocity test shall be carried out by the contractor at his own expense if so desired by the Owner/PMC. Such tests shall be carried out by an agency approved by the Owner/PMC and shall be done under expert guidance using only recommended testing equipment. The acceptance criteria for these tests shall be mutually agreed between the Owner/PMC and the contractor.

 **Supervision**

 All concreting work shall be done under strict supervision of the qualified and experienced representatives of the contractor as well as those of the Owner/PMC. The contractor's engineer and supervisor who are in-charge of concreting work shall be skilled in the class of work and shall personally supervise all the concreting operations.

 **Special attention shall be given the following: -**

1. Proportioning, mixing and quality testing of the materials with particular control on the water cement ratio.
2. Laying of material in place and thorough compaction of the concrete to ensure solidity and absence of voids and honeycombing.
3. Proper curing for the requisite period.
4. Reinforcement and inserts / embedment position are not disturbed during concreting and consolidation by vibration.

 **Quality Control**

 The Owner/PMC reserves the right to make changes in the mix proportions including the increased cement content or / and a change in the contractor's control procedure, should the quality control during progress of the works prove to be inadequate in his opinion.

 All the concrete work shall be true to level, plumb and square within the acceptable tolerance. The corners, edges and rises in all cases shall be unbroken and finished properly and carefully.

 **Testing Room**

 A testing room equipped with the following apparatus and qualified concrete technician, labour and materials required for carrying out tests therein shall be provided by the contractor at his own cost:

1. **Sieve Set (for aggregate 20 mm down)**

 40 mm dia 45 cms.

 20 mm "

 16 mm "

 12.5 mm "

 10 mm "

 4.75 mm "

 600 micron dia 20 cms.

 300 micron "

 150 micron "

 75 micron "

1. **Weighing**

 a) Physical balance cap. 200 gms with weight box (accuracy 0.5 gm)

 b) Counter scale cap. 20 Kg.

 c) Weights

5 kg. ------- 1 No. 500 gms ------ 1 No.

2 kg. ------- 2 Nos. 200 gms ------ 1 No.

1 kg. ------- 1 No. 100 gms ------ 1 No.

1. Slump Cones ---------- 2 Nos.
2. 15 cms moulds ---------- 18 Nos.
3. Electric / Kerosene Heater.
4. Pans etc. as directed by the Owner/PMC.
5. Vicat Apparatus with needles, test tubes, breakers, thick glass plate etc.
6. Measuring Cylinders -------- 1000 ml, 500 ml, 100 ml.
7. Wash bottles ------------ Cap 500 ml --- 2 Nos.
8. Sink
9. Work benches, shelves, desks and any other furniture and lighting as required by the Owner/PMC.
10. Spring balance dial type cap. 100 kg.
11. Litre Measures
	1. 10 lit ----------- 1 No.
	2. 5 lit ----------- 1 No.
	3. 2 lit ----------- 2 Nos.
	4. 1 lit ----------- 1 No.
	5. 1/2 lit ----------- 1 No.

## Standard Concrete Mix Design Presentation

 Grade of Concrete :

 Cement Content and Type :

 Water - Cement Ratio :

 Free Water :

 Specified Strength @ 28 days :

 Current Mean Strength :

 Current Standard Deviation :

 Admixture Type :

 Admixture Dosage :

 Slump @ 30 minutes / slump @ 60 minutes (in laboratory) :

 Air Content :

 Chlorides (as NaCL)\* :

 Sulphates (as So3)\* :

 Combined Aggregate Grading :

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 **Sieve 75 38.1 19 9.5 4.75 2.36 1.18 0.60 0.30 0.15 75**

 **Size mm mm mm mm mm mm mm mm mm mm micron**

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 % Passing

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 **\* Total in mix, expressed as a percentage by weight of cement**

 4.33**Hot / Cold Weather Concreting**

 shall be done as per IS: 7861 (Part I & II).

**Records**

Throughout the duration of this Contract, the Contractor shall maintain on site for inspection by the Owner/PMC up to date records of the information required under this heading and copies shall be supplied to the Owner/PMC to the Performa provided.

1. Complete records of all sampling on site
2. Dates and times recording the sequence of casting of the various portions of the works.
3. Details of all tests carried out
4. All other records as instructed/ required by the Owner/PMC from time to time

## Grouts

 Grouting

i) Grouting shall be done in 1:2 cement mortar (one part cement and two parts coarse sand) of thickness 3" (75 mm) or less, or as directed. Where the thickness is more than 3" (75mm) thick grouting shall be done in plain or reinforced cement with coarse aggregate 3/8" (10 mm) and down gauge. The mix of concrete will be as shown in the relevant drawings as directed.

ii) The base plate shall be temporarily supported on steel wedges and properly aligned before grouting. Forms shall be built around the base and wet mortar shall be placed under pressure around and under the base. To ensure that no air pockets are left after grouting additions holes may have to be cut if directed in the base plate so that pressure grouting can be carried out through these holes also and proper inspection of the grout can be ascertained. The wedges shall be removed after the grouting has set and recess shall be properly pointed.

iii) Grouting of machine foundations shall be done only after taking the written instructions from the Owner/PMC/Architects.

iv) The grouting work is included in the respective item of concrete and the rate for these items and inclusive of proper pressure grouting after preparation of surfaces to be grouted, necessary from work providing and removing necessary wedges, cutting holes in the base plate to ensure that the air pockets are left etc. No extra rate will be paid for grouting or any work that will be necessary to carry out and ensure proper grouting entirely to the satisfaction of the Architects. If however a concrete mix richer than the foundation is specified for grouting, only the difference of the quantity of cement used in richer mix of grout and the mix of the footing shall be paid.

**Special Grouts**

Where so specified special non-shrinking grouts such as Shrinkkomp or ferrogrout shall be used as per instruction and specifications of the manufacturers.

## Damp Proof Course.

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

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

 **Application of Hot Bitumen:** Where so directed, hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete, properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. Bitumen of penetration 80 / 100 or equivalent using 1.7Kg/sqm on clean and kerosene washed surface, A90 or equivalent where used shall be heated to a temperature of 160° ± 5°C. The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere.

## Plum Concrete.

Rubble for soling shall be locally available, stone, or other approved variety. It shall be hard, durable and free from defects such as fissures etc. After excavation/filling has been performed to the required levels, rubble shall be hand set as closely as possible and packed well. Rubbles shall be laid to have their largest area resting on the sub-grade. Rubble packing shall be in one layer of 20/25cms thick. The interstices / voids of rubble will be filled with cement concrete 1:3:6 (1 cement 3 coarse sand 6 coarse aggregate 20mm nominal size). The preparation and laying of cement concrete shall be as contained in relevant specifications for ordinary concrete. Immediately after laying the cement concrete the rubble layer will be rammed by hand rammers and consolidated by surface vibrators. After the cement concrete in the voids is set the topping layer of 100mm thick cement concrete 1:3:6 (1 cement 3 coarse sand 6 coarse aggregate 40mm nominal size) shall be laid and finished smooth for ceiling other structural finishes. The preparation and laying of cement concrete shall be as contained in relevant specifications for ordinary concrete. Necessary form work to support the topping layer shall be done as per relevant specifications for form work. Measurement for this item will be done in cum. The rate shall include all the operations mentioned above including formwork, consolidation, levelling, curing, etc

## Trimix Vacuum Dewatered Flooring.

A recast concrete grill acting as a stop end and rail for surface vibrated to be positioned or separate stop ends and elevated track rails can be used. After placing concrete it shall be poker vibrated, using poker vibration, proper compaction of stone gravels and cement shall be obtained. Voids and entrapped air shall be eliminated. Poker vibration with back up of surface vibration shall ensure the better overall compaction of gravel and stone. Surface vibrator shall run twice over the concerted surface. The machine can be pulled by a winch or manually by experts. For vacuum processing specialised gang shall be engaged in order to produce required compressive strength and wear resistance of the concrete. Suction shall be immediately started after placing, screeding and compaction. Suction mat shall be placed on fresh vibrated surface then vacuum pump is started which is already connected with suction hose and vacuum mat to extract surplus water from concrete. Vacuum processing shall be continued depending upon the thickness of the concrete and water content in concrete shall be lowered to 15 to 25%. After vacuum process floating operation shall take place directly on concrete surface. In these operations, after mixing and grinding of cement takes place for better resistance surface. Also, power trowelled with a skim floater provided by trowelling blades, shall be applied to minimise dusting as well as to improve wear resistance. Minimum two passes of trowelling shall be carried out. The treatment ends with the topping of natural cement colour, while concrete as humid i.e. between floating and towelling. Then surface shall be power trowelled in normal way. Necessary thermocol around column and long peripheral walls shall be provided well in advance of commencement of concreting. Finally one coat of bitumen paint at the sides of concrete thickness all around the panels shall be carried out.

## Concrete Screed

**Description of Work**

The extent of concrete screed floor toppings shall be as shown on drawings. The material should comply with requirements of specification for Cast-in-Place Concrete and as herein specified. The concrete mix to produce concrete screed with the following characteristics:

Compressive strength 25N/mm2 at 28 days.

Slump; 200mm maximum for concrete containing plasticizer and 75mm maximum for other concrete.

Maximum W/C ratio: 0.5.

**Execution**

  **Condition of Surfaces:**

 **Concrete Screed Applied To Hardened Concrete:**

 Prior to placing topping mixture, thoroughly dampen slab surface but do not leave standing water, prime dampened surface and apply specified bonding agent, place screed after bonding compound has dried as per manufacturer’s recommendations.

 Locations of joints in base slab should be marked so that joints in top course will be placed directly over them.

 Toppings shall be laid in bays not exceeding 10 sqm and the bays shall be laid alternately. Bay widths shall not exceed 3.0m.

 At construction join, groove shall be saw cut and filled with approved polysulphide sealant.

 **Placing and Compacting**

 Spread concrete screed mixture on evenly prepared base, bring to required level with straightedge and strike-off. Screed thickness shall be as shown on drawings, minimum 50mm thick.

Where joins are required, construct to match and coincide with joints in base slab. Provide other joints as per criteria mentioned in the clause 7.23. Before execution, contractor shall submit drawing showing layout of construction joints for Architects approval.

 **Trowel Finish**

After floating, begin first trowel finish operation using power drivel trowels. Continue trowelling until surface is ready to receive final troweling. Begin final hand-trowelling when a ringing sound is produced as trowel is moved over surface

 **Curing and Protection**

As soon as screed has set, closely cover with polythene sheeting and keep in position for not less than 7 days.

Take adequate precautions to prevent damage to screeds including covering by suitable means. Make good all defective work in screeds before applying finishes.

 **Performances:**

Failure of concrete topping to bond to substrate (as evidenced by a hollow sound when topped), or disintegration or other failure of topping to perform as a floor finish, will be considered failure of material and workmanship. Repair or replace toppings in areas of such failures, as directed by the Owner/PMC.

## Precast Concrete

 **Precast Nominal Mix Concrete**

1. **General**

 All precast concrete shall be cast by suitable mechanical means for concrete weighing above 50kg, cast over vibrating tables or by using form vibrators for item weighing up to 50kg. The concrete mix shall conform in all respect to "Various Concretes" described in the appropriate paragraph under this section.

 Exposed precast surfaces shall be finished as called for on the drawing or as directed by the Architects. All surfaces coming in contact with in situ concrete shall be wire brushed and hosed down until the aggregate is free from cement slurry. Castellations shall be provided wherever called for. Leaving grouting holes, grooves, inserts, projections reinforcements, lifting hooks etc. shall conform to the erection procedure. All edges and delicate projection likely to be damaged during erection shall be protected by means of wooden cover fillets, until placed in position.

1. **Precast Blocks, Lintels, Bollards, Tree Guards, Kerb Stone, Lamp Post, etc.**

 All precast members shall be exactly of the size and pattern shown on the drawings and shall be made face up in the following manner. All units shall be integrally cast and steel formwork shall be used for making units.

 Provide in the formwork as shown in the drawings. Stiff plastic concrete 1: 1.5 : 3 or as specified / instructed shall be used with coarse aggregate 1/2" (12 mm) and down gauge.

 The precast units shall not be removed from the forms for three days. Precast work shall be cured under cover and shall be kept under water for fifteen days before placing in position.

 Samples of each part shall be approved by the Architects before proceeding with the work.

 Unit may require wetting before bedding. The concrete base shall be wetted and coated with slurry and minimum of mixing water shall be used in the bedding mortar which shall be Portland cement and sand 1:3.

## Specifications for Formwork

 **General**

 **Description**

This section covers the requirements for providing, fabricating and erecting of formwork including propping, bracing, shoring, strutting, rising, bolting, wedging and all other temporary supports to the concrete during the process of setting and subsequent removal of forms. The section also covers the architectural requirements of finished concrete surface obtained from the formwork.

**Contractor shall use proprietary / established system for formwork. Conventional steel/Timber formwork shall not be used.**

 **Applicable Codes and Standards**

The codes and standards generally applicable to the work of this section are listed hereinafter

IS: 456 Code of practice for plain and reinforced concrete

IS: 4990 Plywood for concrete shuttering work

 **SUBMITTALS**

 **Type of Formwork**

Prior to start of delivery of material for formwork, the contractor shall prepare samples of different types of about 10 sqm and obtain approval of the Owner/PMC.

 **Design of Forms**

Before fabricating of forms, the contractor shall submit design calculations for proposed formwork to the Owner/PMC for his approval. However, the approval of the formwork design in no way will relieve the contractor of his responsibility for adequately constructing and maintaining the forms so that they will function properly.

**Design Criteria**

Formwork shall be designed for the loads and lateral pressures due to dead weight of concrete, superimposed live loads of workmen, materials and plants and for other loads as indicated on the drawings.

Forms shall be designed to have sufficient strength to carry the hydrostatic head of concrete as a liquid without deflection tolerances exceeding the acceptable limits.

 **Erection of Formwork**

Forms shall be used wherever necessary to confirm the concrete during vibration and to shape it to the required lines. The formwork shall conform to shapes, lines, levels, and dimensions of the concrete sections shown on the drawings with no crevices at joint.

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete and shall be maintained rigidly in position. Formwork shall be adequately supported by adequate number and size of struts, braces, ties and props to ensure rigidity of forms as to retain form work position without displacement or deflection during the placing and compaction of concrete. Where props rest on natural or filled up ground, to avoid any settlement, the soil shall be thoroughly compacted and bases of props shall be of sufficient size so as to restrict the bearing pressure on the ground to 5 T / sqm.

Forms shall be tight enough to prevent loss of mortar from the concrete and to produce a dense, homogeneous and uniformly coloured concrete completely free from honeycombing or surface roughness. Joints in formwork shall be designed to prevent leakage, not only between individual elements forming the panels but also from the horizontal and vertical junction between the panels themselves.

Contractor has to take all necessary care to minimize fins, ridges, offsets, leaking of fins and other defects.

If formwork is held together by bolts or wires, those shall be so fixed that no reinforcement bar is exposed on surface against which concrete is to be laid. The Owner/PMC may at his discretion allow the contractor to use tie bolts running through the concrete at his own cost.

Hole left in the concrete by these tie-bolts shall be filled as specified by Owner/PMC, by the contractor at his own expense.

Formwork shall be constructed so as facilitate loosening and permit removal without jarring the concrete. Wedges, clamps and bolts shall be used wherever practicable instead of nails.

 **Field Quality Control**

All formwork erected shall be inspected & approved by the Owner/PMC before concreting/Reinforcement is started.

 **Cleaning and Oiling Of Forms**

At the time concrete is placed in the forms, the surface of the forms in contact with the concrete shall be free from encrustation of mortar, grout or other foreign material. Temporary openings shall be left at the bottom of formwork to enable sawdust, shavings, wire cutting and other foreign material to be worked out from the interior of the forms before the concrete is placed.

The surface of the forms to be in contact with the concrete shall be coated with an approved coating that will effectively prevent sticking and will not stain the concrete surfaces. After each use the surfaces of forms in contact with concrete shall be cleaned, well wetted and treated with form oil approved by the Owner/PMC **Lubricating (machine) oils shall not be used**.

Oiling shall be done before reinforcement has been placed and care shall be taken that no oil comes in contact with the reinforcement while it is being placed in position.

Immediately before concreting is commenced the formwork shall be carefully examined to see that all dirt, shavings, sawdust and other refuse have been removed and the formwork shall be wetted thoroughly to prevent absorption of water from concrete. The formwork shall be kept wet during concreting and for the whole time that it is left in place.

 **Removal of Formwork**

Formwork shall be removed carefully so as to prevent damage to the concrete. Wooden wedges only shall be used between the concrete surface and the form where force is necessary to separate the form from the concrete. Metal wedges, bars or tools shall not be used for this purpose. Any concrete damaged in the process of removing the forms shall be repaired in accordance with the provision of concrete specifications.

Removal of bottom form linings between props prior to the removal of supports may be permitted provided the formwork has been designed to allow such removals without disturbing the supports.

All non-supporting forms shall be loosened and removed during regular working hours, and as soon as the concrete has hardened sufficiently to prevent damage from the removal of the forms. All false work and forms supporting concrete beams and slabs, or other members subject to direct bending stress, shall not be removed or released until the concrete has attained sufficient strength to ensure structural stability and to carry both the dead and live loads including any construction loads which may be placed upon it.

Unless otherwise permitted in writing by the Owner/PMC, the forms shall not be stripped in less than the minimum periods specified in IS: 456. However the Owner/PMC may increase the above period if he considers it necessary for structural stability. No permanent structure shall be erected on any part of the structure while it is still supported by formwork unless walls are built above another wall carried on a properly supported base.

All formwork shall be struck without jarring the concrete or subjecting it to sudden shocks.

Supports shall be slowly eased so that the concrete is stressed gradually during striking of the formwork.

No construction loads exceeding the combination of superimposed dead load plus specified live load shall be supported on any unshared portion of the structure under construction, unless analysis indicates adequate strength to support such additional loads.

If props are required to support loads imposed by subsequent construction work at the same level, for example in shrinkage bays, they shall not be removed until such subsequent construction has attend its specified 28 days strength.

Formwork shall be removed in such a manner so as not to impair safety and serviceability of the structure. It shall be removed gradually to prevent sudden application of loads to the concrete. All concrete to be exposed, shall have sufficient strength to prevent any damage caused by removal of formwork.

For all normal conditions where the early crushing strength is not known the following table may be used as a guide: -

 Type of Formwork Minimum period before striking surface

 Temperature of concrete

 16 Deg.C. 7 Deg. C.

 Sides of unloaded beams, walls & columns. 2 Days 3 Days

 Soffits of slab (Props left under) 10 Days 14 Days

 Soffits of Beams (Props left under) 10 Days 14 Days

 Props to slab 14 Days 21 Days

 Prop to Beam 15 Days 21 Days

  **Architectural Finishing Surfaces**

 **Formwork for Exposed Concrete Surfaces**

Where it is desired, directed or shown on the drawings to have original fair face finish of concrete surface without any rendering or plastering, formwork shall be carried out by using material of approved quality and as per direction of the Owner/PMC.

The Contractor shall use one type of material for all exposed surfaces and the forms shall be constructed so as to produce a uniform and consistent texture and pattern on the face of the concrete. Patches on forms for these surfaces will not be permitted. The formwork shall be placed so that all horizontal formworks are continuous across the entire surface. If forms are constructed of lumber and are not panelled the formwork shall be staggered. To achieve a finish, which shall be free of board marks, the formwork shall be faced with plywood or equivalent material in large sheets. The sheets shall be arranged in an approved pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features, sills, window heads or change in direction of the surface. All joints between panels shall be vertical or horizontal unless otherwise directed. Suitable joints shall be provided between sheets. The joints shall be arranged and fitted so that no blemish or mark is imparted to the finished surfaces.

To achieve a finish which shall give the rough appearance of concrete cast against sawn boards, formwork boards unless otherwise stated shall an average 150mm wide, securely jointed with tongued and grooved joints if required to prevent grout loss with tie rod positions and directions of boards carefully controlled. Sawn boards shall be set horizontally, vertically or at an inclination as shown in the drawings. All bolt holes shall be accurately aligned horizontally and vertically and shall be filled with matching mortar recessed 5mm back from the surrounding concrete face.

Forms for exposed concrete surfaces shall be constructed with grade strips (the under side of which indicates top of pour) at horizontal construction joints, unless the use of groove strips is specified on the drawings. Such forms shall be removed and reset from lift to lift. Sheathing of reset forms shall be tightened against the concrete so that the forms will not spread and permit abrupt irregularities or loss of mortar. Supplementary form ties shall be used as necessary to hold the reset form straight against the concrete.

For fair-faced concrete, the position of through bolts will be restricted and generally indicated on the drawings. Chamfer strips shall be placed in the corners of forms for exposed exterior corners so as to produce 20mm bevelled edges except where otherwise shown in the drawings. Interior corners and edges at formed joints shall not be bevelled unless shown on the drawings.

Mouldings for grooves, drip courses and bands shall be made in the form itself. The wood planks, plywood and steel plates used in formwork for obtaining exposed surfaces shall not be used for more than 3 times in case of wood planks, 6 times for plywood and 10 times for steel plates respectively. However no forms will be allowed for reuse, if in the opinion of the Owner/PMC is doubtful to produce desired texture of irregularities of exposed concrete.

 In order to obtain exposed concrete work of uniform colour it shall be necessary to ensure that the sand used for all exposed concrete work shall be of approved uniform colour. Moreover the cement used in the concrete for any complete element shall be from single consignment.

No exposed concrete surface shall be rendered or painted with cement or otherwise. Plastering of defective concrete as a means of achieving the required finish shall not be permitted, except in the case of minor porosity on the surface the Owner/PMC may allow a surface treatment by rubbing down with cement and sand mortar of the same richness and colour as for the concrete. This treatment shall be made immediately after removing the formwork.

The contractor shall also take all precautionary measures to prevent breaking and chipping of corners and edges of completed work until the building is handed over. Extra payment for shuttering of exposed surface of concrete shall be made for such exposed surfaces as are visible after the completion of work.

No extra payment of surfaces covered under false ceilings, skirting, veneering, or for shuttering have exposed surfaces of concrete as are not visible after the completion of the work shall be made under this item. No extra claims on account of working chamfers, grooves, drip courses, band etc. shall be entertained.

 **Finishing of Formed Surfaces**

Unless otherwise specified after removal of forms the surfaces of concrete shall be given one or more of the finishes specified below in locations designated by the contract documents.

 **Cement Plaster Finish.**

The concrete surface shall be properly roughened immediately after the shuttering is removed, taking care to remove that laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give good bond between concrete and plaster. After surface preparation the exposed formed surface of RCC work shall be plastered with cement mortar 1:3 of thickness not less than 6 mm to give a smooth and even surface true to line and form.

 **Rough Form Finish**

No selected form facing materials shall be required for rough form finish surfaces. Tie holes and defect shall be patched with cement mortar. Fins exceeding 6mm in height shall be chipped off or rubbed off. Otherwise, surfaces shall be left with the texture imparted by the form.

 **Smooth Form Finish.**

The form facing material shall produce a smooth, hard uniform texture on the concrete. It may be plywood, tampered concrete-form-grade hard board, metal, plastic, paper or other approved material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical with the number of seams kept to the practical minimum. It shall be supported by studs other backing capable of preventing excessive deflection material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All the fins shall be completely removed.

 **Architecturally Exposed as Cast Finish.**

The formed surfaces shall be left as it comes out after removal of forms, barring minor patching. Control is to be exercised on choice of materials of concrete, cover of concrete shuttering, etc. as detailed out in the specifications for architecturally exposed concrete.

 **Architecturally Exposed Smooth Rubbed Finish.**

General requirements of architectural exposed concrete shall govern. The form work shall be chosen to produce smooth form finish-smooth rubbed finish shall be produce on newly hardened concrete no later than the day following from removal. Surfaces shall be wetted and rubbed with carborandum stone or other abrasive until uniform colour and texture are produced. No cement grout shall be used other than the cement paste drawn from the concrete itself by the rubbing process.

## Joint Fillers

 **Material**

The joint filler shall be of approved make and specification. The material shall be firm, soft enough to bend to certain extent and shall be well soaked in preservatives such as bitumen etc. the material shall be durable and free from attached by termites. The thickness shall be as per specification. The flat surface shall with stand green concrete and shall not adversely affect the concrete. It shall have compressibility (sprint action) without becoming powder or crushed. After release of pressure it shall come back to its original thickness.

 **Submittals**

Contractor shall submit to the Owner/PMC for his approval the manufacturer’s data of the product and all related information as required by the Owner/PMC.

 **Placing**

Depending upon the type of filling it shall be placed pre or past concreting. In the expansion joints it shall be fixed on the concrete / masonry surface already constructed by means of adhesive such as bitumen synthetic adhesives. The excess material shall be cut off with knife-edge to bring it in to exact shape. The knife cut edges shall be treated, with bitumen or similar so as to avoid soaking of water from that surface.

 **Filling in Gaps**

The material can also be used for filling the gaps, by cutting it in to small strips of required width and filling it within the gaps with the help of bitumen or synthetic adhesives.

##  Water Repellent Sealant

Approved water repellent sealant shall be provided to all faces of precast element, which are exposed to weather or as specified on the drawing.

## Specification for Steel Reinforcement

 **General**

 **Description**

 This section covers the requirements for fabricating, delivering and placing of steel reinforcement for all types of concrete work.

 **Applicable Codes and Standards**

 The codes and standards generally applicable to the work of this section are listed hereinafter

 IS : 280 Mild Steel wire for general engineering purposes.

IS : 432 Part I Mild Steel and medium tensile steel bars Part II Hard drawn

 steel wire.

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

 IS : 814 Covered electrodes for metal arc welding of structural steel.

IS : 816 Code of practice for use metal arc welding for general construction in mild steel.

IS : 1139 Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement.

 IS : 1566 Hard-drawn steel wire fabric for concrete reinforcement.

 IS : 1786 Cold-twisted steel bars for concrete reinforcement.

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

 IS : 2629 Recommended practice for hot-dip galvanising of iron and steel.

IS : 3370 Code of practice for concrete structures for (part I to IV) the storage liquids

 IS : 4759 Hot-dip zinc coating on structural steel and other allied products.

 The following clauses are intended to amplify the requirements of the reference documents listed above and the contractor / owner shall comply with these clauses.

 **Submittals**

 **Test Results**

 When not given in the tender documents, before commencement of fabrication of any steel reinforcement, the contractor shall submit the test reports for all dia meters to reinforcing steel which he has procured for incorporation into works to the Owner/PMC, for his approval.

 **Reinforcement**

 Reinforcement steel shall be any of the following types :

 Type – I : Plain rounded bars

 Type – II : Welded Wire Fabrics

 Type – III : Cold Twisted Deformed Bars

 Type – IV : Thermo Mechanically Treated Ribbed Bars

 Type – V : Thermo Mechanically Treated Ribbed Corrosion Resistance Bars (Copper Bearing)

 Unless specifically shown on the drawings or instruction issued in writing by the Owner/PMC, steel of any grade or Type other than those specified in clause above shall not be used for the purpose of concrete reinforcements.

 Type and Grade of steel to be used in a work shall be verified from the Owner/PMC before procuring such steel.

 **Manufacturer’s Guarantee**

 Depending on the process the chemical composition of steel may vary from manufacturer to manufacturer. However, the manufacturer shall give the guarantee that when combination of different grades and different types of steel are used in conjunction and are placed in contact, there is no bimetallic action causing enhancement of the process of corrosion.

 **Quality Assurance**

 a) At least one sample from each category must be tested for strength, elongation, P, S & C%, Bend ability.

 b) At least one sample per 40T of quantity must be tested.

 Based on test results as specified above, the Owner/PMC will be the sole authority to accept or reject the consignment of steel, and such decision shall not be influenced by the results of tests as per manufacture’s certificate.

 **Detailed Bar Bending Schedules:**

 Contractor has to submit detailed Bar Bending Schedule to the Owner/PMC for his approval before reinforcement is bent and/ or fixed.

 **Materials**

 **Steel Reinforcement**

 Steel reinforcement used shall be either of the following types:-

1. Mild Steel of Grade I tested quality conforming to IS: 432 Part I.
2. High yield strength cold worked deformed/ Ribbed steel bars of tested quality conforming to IS: 1786 or hot rolled high tensile deformed steel bars of tested quality conforming to IS: 1139.
3. Hard drawn steel wire fabric conforming to IS: 1566.
4. Where galvanised reinforcement is specified in the drawings, the bars or mesh shall be hot-dip galvanised after bending generally in accordance with IS: 2629 and IS: 4759. Galvanised reinforcement shall be coated with a layer of zinc nowhere less than 0.05 mm in thickness.

All steel shall be procured from original producers and **no rerolled** steel shall be incorporated in the work. Only new steel shall be delivered to the site and shall be free from mill scale, loose rust, grease, oil, paint or any other deleterious material, which reduces or destroys bond. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

Tight rust and mill scale or surface irregularities shall be acceptable, provided the weight and the dimensions including height of deformations and tensile properties of a test specimen which has been wire brushed with hand, are not less than those required by the applicable Indian Codes and Standards.

 **Binding Wire**

Binding wire shall be black annealed steel wire conforming to IS: 280 and of minimum 16 -18 gauge.

 **Welding Electrodes**

Electrodes used for welding of steel bars shall be ordinary mild steel grade electrodes conforming to IS: 814 and shall be of the best quality approved by the Owner/PMC.

 **Storage**

Reinforcement steel shall be handled and stored in a manner that bending or distortion of the bars is avoided All reinforcement shall be stored horizontally above ground level on supports skids or other approved supports, clear of any running or standing water. Contact with soil should be avoided. Proper drainage and protection from the elements shall be provided to minimise corrosion.

 Bars of different classifications and diameters shall be stored separately.

A record shall be kept of the batch numbers of reinforcement deliveries in such a form that the part of the works in which particular reinforcement is used can be readily identified.

Welding electrodes shall be stored in moisture controlled environment in accordance with the manufacturer's recommendations.

 **Fabrication**

Reinforcement steel shall be carefully and accurately cut, bent or formed to the dimensions and configurations shown on the drawings and bar bending schedules.

All reinforcement shall be bent cold using appropriate pin sizes. Bars may be preheated only on approval of the Owner/PMC. Hot bars shall not be cooled by quenching. Bends shall be in accordance with IS : 2502.

It shall be ensured that the bars are not bent or straightened in any manner that will injure the material. Any bars incorrectly bent shall be used only if means for straightening and rebinding be such as not to affect adversely the material. Reinforcement shall not be re-bent or straightened without prior review by the Owner/PMC. No reinforcement shall be bent when in position on the works without approval of the Owner/PMC, whether or not it is partially embedded in hardened concrete.

Reinforcement steel having a reduced section, visible transverse cracks in bends, or otherwise damaged in anyway shall not be used.

Spiral reinforcement shall be accurately fabricated to the diameter and pitch shown on the drawings. One and one half (1.1/2) finishing turns shall be provided at both top and bottom unless shown otherwise.

Cut ends of galvanised rods shall be given a protective coat of an approved zinc paint immediately after cutting.

 **Lapping**

As far as possible bars of maximum length available shall be used. All bars shall be in one length unless otherwise shown on the drawings or agreed with the Owner/PMC.

Laps shown on the drawings or otherwise specified by the Owner/PMC shall be based on the use of bars of maximum length by the contractor. In case the contractor wishes to use shorter bars, laps shall be provided at the contractor's cost in the manner and locations approved by the Owner/PMC.

Not more than 1/3 rd of the bars or as specified in the drawings shall be lapped at one section.

Reinforcement bars shall not be welded unless shown on the drawings or instructed by the Owner/PMC.

 **Placement**

All reinforcement shall be placed accurately and maintained in the position indicated on the drawings.

The contractor shall provide approved type of supports/ spacer for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as called for in the drawings. Precast cement concrete blocks of required shape and size, M.S. chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Precast concrete blocks shall be cast well in advance and shall be at least equal in quality to the class of concrete specified in the work.

In fair faces of concrete, temporary spacers only shall be used and removed or with-drawn as compaction of concrete proceeds. Spacers will not be permitted to be left in fair faces of concrete.

All intersections of the reinforcements shall be securely tied with two strands of binding wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

Tack welding of crossing bars shall not be done except as authorised or directed by the Owner/PMC. Nothing extra will be paid for tack welding.

The contractor shall take all reasonable precautions to ensure that when handling or erecting reinforcement no damage shall be done to finished concrete. Bars that are partially embedded in concrete shall not be field bent unless concurrence has been obtained from the Owner/PMC.

Walkways and borrow runs for placing and compacting the concrete shall be independent of the reinforcement.

Loose binding wire and other extraneous metal shall be removed from inside the formwork prior to concrete placing.

Without relieving the contractor of the responsibilities for the correctness thereof, the reinforcement shall be inspected and approved by the Owner/PMC in writing before any concrete is placed and the contractor shall allow sufficient time for such inspection and any subsequent remedial action to be carried out. No part of the reinforcement shall be used for conducting electrical currents.

 **Cover To Reinforcement**

Unless shown otherwise on the drawings, minimum cover for all reinforcement shall be provided as per IS: 456. Care shall be taken to maintain the correct cover to reinforcement.

For concrete members exposed to weather, earth, action of harmful chemicals, acid vapour, saline atmosphere, sulphurous smoke etc. minimum cover for reinforcement shall be increased by 15 mm to 40 mm as directed by the Owner/PMC.

For concrete members of water retaining structures minimum cover for reinforcement shall be as stipulated in IS: 3370 Part II.

The maximum cover for reinforcement shall not be greater than that specified above or shown on the drawings plus 10 mm except for bundled bars.

For bundled bars, minimum concrete cover shall be equal to the equivalent diameter of the bundle but need not be greater than 50 mm.

Exposed reinforcement intended for binding with future extensions shall be protected from corrosion as shown in the drawings.

 **Clearing**

After placing, the reinforcement shall be maintained in a clean condition until the concrete is placed. On no account the bars shall be oiled or painted or mould oil used on the formwork be allowed to come in contact with the bars.

Before concreting is commenced, the bars shall be thoroughly cleaned with dry gunny bags if they are coated lightly with rust or other impurities.

Weld mesh/ IRC fabric wherever required to be used as reinforcement shall confirm to IS: 1566 - 1985

## Structural Steel Work

**General**

 The Scope of work covered under this contract comprises the supply fabrication and erection of structural steel work in acceptance with drawings and as directed in bill of quantities and specifications hereinafter.

 **Material**

The current rules and practices set forth in latest standards of Bureau of Indian Standards for materials fabrication and erection of structural steel work including metal arc welding shall be strictly followed unless otherwise indicated hereinafter.

 All steel work shall confirm to IS : 800 : 1962 and shall be free from defects impairing strength durability or appearance and shall be of the best tested commercial quality for purpose specified, and possessing structural properties to withstand safely the stresses to which these shall be normally subjected. The contractor shall bear the costs.

 **Design Detailing**

In case the contractor wishes to suggest certain alterations, substitutions or modification of design sections, details etc, he shall provide necessary drawings therefore, together with stability calculations and details. These details shall be checked by structural engineer and finally approved by the Owner/PMC.

It is intended that the drawings and specifications include every thing requisite and necessary to finish the work properly notwithstanding the fact that every time it may not be specifically mentioned. All supplementary points such as bolts, nuts, washers, shims, chips and angles to complete each time, shall be deemed to be included though not specifically stated. All work when finished be delivered in a complete and undamaged state.

 **Quality Assurance**

 **Inspection**

 All material, fabrications and the erection may be subject to inspection by the Owner/PMC. Facilities shall be afforded by the Contractor for inspection at any reasonable time.

 **Indemnify for design and safety**

The Contractor shall indemnify the Pr. Mgr. against all proceedings, cost, claims, expenses and liabilities whatsoever arising out of or in connection with the design work for which he is responsible

The Contractor is entirely responsible for the stability and safety of structure during erection and for the checking of structural adequacy of, and testing of, the temporary works and shall indemnify the Owner/PMC against all proceedings, cost, claim, expenses and liability whatsoever arising from, or in connection with accidents in these respect.

 **Product Quality**

 All material shall be of approved manufacture. The Contractor shall at his own expense, furnish the Owner/PMC with copies of manufacturer’s test certificates of the steel to be supplied in accordance with the relevant Indian Standard Specifications and with the requirements of drawings. Such certificate shall not relieve the Contractor of his responsibilities to ensure that only steel complying with the said requirements shall be used. Unbranded steel either receive from the mill or lasted Contractor’s stock will be rejected. Furthermore, whenever required by the Owner/PMC, Contractor is obligated to submit to an approved laboratory samples of steel to be subjected to test as per Indian Standard Specifications.

Welds shall be inspected by the independent authority as approved by the Owner/PMC. The independent authority will provide reports/ comments directly to the Owner/PMC. The Contractor shall allow for having 15% of all site and shop fillet welds and 100% of butt welds tested.

 **Applicable Codes and Standards:**

 The codes and standards generally applicable to the work of this section are listed hereinafter.

 IS : 800 Code of practice for general construction in steel.

 IS : 801 Code of practice for use of cold formed light gauge steel

 structural members in general building construction.

 IS : 806 Code of practice for use of steel tube in general building

 construction.

IS : 807 Code of practice for design, manufacture erection, testing of crane and hoists

 IS : 811 Specification for cold formed light gauge structural steel section

IS : 816 Code of Practice for use of Metal welding under General Construction in Mild Steel.

IS : 875 Part I to V Code of practice for design loads (other than earth quake) for buildings and structures.

 IS : 914 Code of practice for covered electrodes for metal arc welding.

 IS : 1148 Specifications for rivet bars.

 IS : 1200 Method of measurement of building and civil engineering works

 IS : 1477 Code of practice for painting of structural steel works.

 IS : 1786 Specification for high strength deformed bars

IS : 1838 Performed fillers for expansion joints in concrete- non-extruding

 and resilient type.

 IS : 1893 Criteria for earth quake resistant design of structures.

IS : 1946 Code of practice for use of fixing devices in walls, ceilings, and

 floors of solid construction.

 IS : 2751 Recommended Practice for welding for reinforcement bars.

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

 IS : 4014 Code of practice for steel tubular scaffoldings.

 IS : 4082 Recommendations on stacking and storage of construction

 materials at site.

 IS : 7205 Safety code for erection of structural steel works

 IS : 7215 Tolerances for fabrication of steel structures

 **Materials**

 All materials used shall be new, first quality composition conforming to the following specifications:

1. **Steel, Bolts and Nuts:**

 All structural steel shall be of tested quality and shall comply with the requirements of IS 226. Mild steel nuts and bolts shall be made from steel of round bar quality and not from rivet bars. All rivet bars shall comply with IS: 1148 Rivet bars for structural purpose. All bolts and nuts shall be made in accordance with relevant IS or BS specification and unless shown or specified otherwise are to hexagonal. Maker’s Test certificate shall be made available to the Owner/PMCs when called for.

 Ordinary boots shall confirm relevant standards for hexagonal head bolts, for countersunk or cup, head bolts. Nuts shall be of at least the strength grade appropriate to the grade of bolt or other threaded element with which they are used. Plain and taper washers shall comply with the requirements of Indian Standards as appropriate.

 Wherever particularly specified, the high strength friction grip bolts and associated nuts and hardened washers shall be used and these shall be to Indian Standards. Approved load indicating bolt or a load indicating washer shall be used in all high strength friction grip bolt assemblies. Holes for friction grip fasteners, the contact surfaces and the use of friction grip bolts shall all be in accordance with Indian Standards.

1. **Steel Tubes:**

Steel tubes if used in construction shall be of tested quality and shall comply with the requirements of IS-1161 or to the latest edition to the latest edition of B. S. S. 1775, including all amendments and addendums thereof.

 The structural hollow sections shall comply with relevant specifications and IS standards.

1. **Pipe Sleeves:**

 Pipe shall be 6mm thick Min. Galvanised Iron.

1. **Sections**

 Sections used in the fabrication of members shall be cut from one piece of material.

1. **Steel Plates**

 Steel plates items shall be fabricated of the materials sizes and thickness and installed at locations as indicated on the drawings and shall be furnished complete with anchors and fastenings.

 Notwithstanding any other clause contained in this specification the standard of materials and workmanship shall be in no way inferior to the recommendations contained in Indian Standards.

1. **Submittals**

 Each steel section piece obtained from the rolling mill supplier shall be marked as required by IS codes including the special quality identification or equivalent Indian Standards mark required by relevant IS codes. The contractor shall submit manufacturer’s certificates and test sheets including chemical composition as required by IS codes in respect of all sections and plates to be used in the works and as instructed by the Owner/PMCs.

 **Design Drawings and Shop Drawings.**

 The structural steel framework and metal roofing and cladding work shall be carried out as indicated on drawings.

 **Design drawings**

 The contractor shall submit shop drawings (at least 28 days before the commencement of fabrication works) to the Structural Engineer / Architects for approval, along with structural calculations for each typical and critical joints. These shall show full size sections of all joints and connections, thickness of materials used and details of welds, bolts, rivets etc. shop drawings shall clearly distinguish between shop and field rivets, bolts & welds. Shop drawing shall be made in conformity with IS code for shop drawings and with due regards to speed and economy in fabrication and erection. A marking diagram allotting distinct identification mark to each separate piece of steel work shall be prepared. The diagram shall be sufficient to ensure convenient assembly and erection at site. All shop drawings shall show temporary bracing and connections required during fabrication and erection. The contractor shall submit the calculations for temporary erection joints and support structures. All shop drawings shall be prepared in advance of the actual fabrication. The shop drawings shall carry detailed bill of materials indicating identification number of each element, left and right ends of member, corresponding member numbers, length of each units, number of repeats of each units, unit weight and total weight.

 On final completion, Contractor has to submit for record purposes four copies of as built drawings showing all variations.

 **Design, Fabrication and Workmanship:**

 All structural steel work shall be designed and executed in accordance with IS 800 “Code of Practice for use of structural steel in General Building Construction” and loading shall be in accordance with IS 875 “Code of Practice for Structural Safety of Building Loading Standards” where applicable.

 All smithy work shall be clean and sound and the metal shall not be burnt or injured in anyway. Individual members shall, unless shown otherwise on the drawings or agreed in writing by the Owner/PMC, be fabricated from continuous un-jointed sections.

 No drifting shall be allowed except for bringing together several parts forming a member but the drifts must not be driven with such force as to disturb or damage the metal shall be used where necessary.

 Particular care must be taken to ensure free expansion and contraction wherever provided for in drawings and specifications.

 The method of fabrication and assembly shall be in accordance with the best-accepted practice. Unless otherwise specified or noted all work shall be installed and / or erected true to lines and planes with vertical lines, plumb and horizontal lines level.

 Unless otherwise specified, all abutting surfaces depending on contact for the transmission of compressive loads or forces shall be machined (together with gussets where present already welded on) so that the whole area of abutting surfaces is in direct contact. Faces which are to be grouted directly to a foundation need not be dressed.

 Caps, bases and end plates shall be fixed to the member concerned prior to erection. Unless indicated otherwise on the drawings such caps, bases and plates shall be truly at right angles to the member axis.

 The ends of all beams shall be accurately cold sawn. End cleats must not project more than 2.0m beyond the end of the beam.

 The welding procedures shall be arranged to avoid distortion of the completed member. Work that is deformed by shrinkage after welding will be rejected and it to be made good at the contractor’s expense.

 Sheared edges of gussets or other members shall be straightened and dressed where necessary.

 Shop connections shall be either welded or bolted unless otherwise indicated on the drawings. Site connections shall be bolted or welded as indicated on the drawings.

 All holes shall be drilled to template, through all thickness in one operation, where possible, and all burrs removed. The diameter of the hole must not exceed the diameter of the bolt for which it is drilled by more than 2.0mm. All bolts shanks shall be solid with heads and lengths sufficient to allow not less than two clear threads projections beyond the nuts after tightening. The length of the unscrewed shank or barrel shall be at least equal to the thickness of the members to be connected. Round washers shall be provided under all nuts. On bevelled surfaces square taper washers of 5mm mean thickness shall be used under nut or head, as appropriate.

The Contractor shall, as part of the contract, provide all necessary assistance which the Owner/PMC/Engineer may require for checking the setting out. The Contractor shall take care to see component parts fit correctly and according to the distinguishing match marks.

 All members must be so formed that they may be accurately assembled without being unduly packed, strained or forced into position, and when built shall be true and free from any twist, kink, buckle or open joints between component pieces. Failure in this respect involves the rejection of the defective member.

 Greatest accuracy is to be observed to facilitate erection at site and all corresponding parts must be made inter-changeable. All loose, faulty tallow. Screwed ends of time rods and anchor bolts or machined surfaces shall be efficiently protected from injury during transit.

 **Architecturally Exposed Structural Steel**

 **General:**

 Members required to be Architecturally Exposed structural steel are to be fabricate with special care using material selected for best appearance. Employ necessary fabricating techniques to produce and maintain the required quality of work and tolerances. Make exposed edges and ends square and smooth, free of cutting marks, shear distortion, burrs, and nicks. Provide uniform and consistent joints with all exposed copes, mitres and butt cuts. Do not apply permanent mill markings, erection marks, symbols, or painted notes on exposed surfaces.

 **Welding of Architectural Steel**

 Select weld sizes, sequence and equipment to limit distortions within allowable tolerances. “Print through” or “dimpling” on exposed surfaces is not acceptable. Continuously weld joints. Grind welds smooth and otherwise treat as required to blend with adjacent parent metal. Where flush butt joints are required, make welds slightly oversized and grid flat.

 **Filling of Architectural Painted Steel:**

 Apply epoxy filler to pockets, voids, pitting or other blemishes on exposed surfaces of architectural painted steel, including on faces and welds.

 **Item Embedded In Concrete Or Masonry**:

 Structural steel items, such as shear channels, beams, girders, trusses, plates and similar installations shall be fabricated and installed as shown on the drawings to field measurement where required.

 **Specification for Welding:**

1. Qualification for Welders:

 All welding operations shall be carried out by skilled welders who shall satisfy the requirement of IS 1181

 “Qualifying test for metal arc Welders engaged in welding structures other than pipes.”

 All welders employed for welding operations in the work shall be competent welders to the satisfaction of the Owner/PMC/ Engineer having appropriate trade certificates and experience in the filed.

1. Electrodes:

 Electrodes complying with IS 914: Covered Electrodes for Metal Arc Welding of Mild Steel or British Standard 639 – “Covered Electrodes for metal Arc Welding” shall be used.

1. Workmanship:

 Welding shall be by the Metallic ARC process, using electrodes complying with the requirements of IS codes. The whole of the work shall be accordance with the requirements of Indian Standards.

 The surface of the parts to be welded at a distance of 25 mm on either side shall be free from loose rust, mill scale & greece, and shall be thoroughly clean. The light film of rust remaining after wire brushing need not be further cleaned of. Where edges are required to be bevelled are otherwise shaped this may be done by any mechanical process, but not by hand gas cutting. The surface to be welded shall be reasonably smooth and free from sharp irregularity. The angle and shape of the prepared surfaces shall comply with the requirement of the appropriate Indian Standard code of Practise. Any steel work to be site welded shall be cleaned back to bare metal to the satisfaction of the Owner/PMC/Engineer in the area to be affected by the weld and subsequently repainted in accordance with this specification.

Single U, V, J or bevelled but joints shall be reinforced when ever possible by a run of weld on the backside of the joints.

 In case where this is impracticable the effective thickness at the centre of the reinforcement shall be 10 % greater than the thickness of the parent metal.

 All welds between flanges and webs and between end plates and girders shall be full strength, full penetration butt welds.

 Welding of mild steel shall be in accordance with IS 816 “Code of Practice for use of Metal arc welding under General Construction in Mild Steel”. Unless otherwise specified, all welds shall be 6mm, single fillet welds. Welds should be made in the flat position, wherever possible. Welders shall work under constant competent supervision in a properly organized manner with quality welding sets and with suitable electrodes all to the approval of project engineer and to his satisfaction. Special attention should be given to a suitable sequence of welding to keep the internal stresses within admissible limits.

1. Welding:

 Adequate steps shall be taken to maintain the correct arc length, rate of travel, current and polarity for the type of electrode and nature of work.

 Structural steel shall not be painted or oiled on any area, where welding is to be performed and shall be well cleaned to remove any paint, scale or rust immediately before welding for a distance of at least 2 cm. on either side.

 The work shall be securely held in position by means of tack welds, service bolts, clamps or jigs before commencing welding so as to prevent any relative movement due to distortion, wind or other causes. When welding is liable to cause distortion, the work shall be securely held in approved frames or jigs.

 Freedom of movement of one member of the joint shall be allowed, wherever possible. No butt joint shall be welded without allowing one component freedom of movement of the order of 1/16” (2 mm).

1. Sequence of welding

 The sequence of welding shall be such that when possible the members which offer the greatest resistance to compression are welded first.

 The welding of a joint shall be arranged so that the resulting tensile and compressive stress produced by each portion of the weld tend to balance each other. The step back method of welding shall be adopted for continuous runs.

 Fusion faces may be cut by shearing, chipping or machine gas cutting. Head cutting by gas may be substituted for machine gas cutting only, if the later is impracticable and the cutter shall be adequately guided so that the cut edge is clean and uniform. If the fusion face is rough, it shall be dressed by chipping, filing, or grinding in a satisfactory manner.

1. Rectification of improper welds

 Welds showing slag inclusion, porosity or lack of proper penetration shall be cut and rewelded. Overlap of the toe of the weld and under-cutting of the parent metal should be avoided and where present to serious extent shall be rectified.

1. Slag removal

 All slag shall be removed from each rub before another run is super-imposed and from the final run. The final run shall be protected with clean boiled linseed oil and shall not be painted until approved by the Architects or his representative at site.

1. Grinding

 Grinding of finished welds is permitted provided the weld is not reduced below the prescribed section. All exposed welds shall be ground smooth.

All welds, which have not been ground, shall be scrubbed, with a 10% solution of hydraulic acid which shall be washed off with water before paint is applied unless alkali resisting paint is used.

The contractor shall employ a competent welding supervisor or charge hand to ensure that the standard of workmanship and the quality of the materials comply with the general requirements.

 **Storages:**

 Contractor shall take all necessary precautions to minimise expose to chemical pollution of steel awaiting fabricating.

 Fabricated steel work which is stored awaiting delivery to site or refection, shall be kept clear of the ground and shall be laid out or stacked so as to reduce to a minimum the amount of water or dirt that can accumulate on or against any of the surfaces.

 Suitable packing shall be placed between layers of stacked steel work. Where cover is provided, it shall be ventilated sufficiently to keep condensation to a minimum.

 **Welding Program to Owner / PMC.**

 The contractor shall submit in writing to the Owner/PMCs giving full details of the proposed welding procedures, which the contractor proposes to adopt for each type of weld in the work prior to commencement of work.

 **Inspection of Works**

 The Structural engineers / Owner/PMCs and his representative shall have free access to work being carried out by the contractor at all reasonable times, and facilities shall be provided so that during the course of welding he may be able to inspect any layer of weld metal. He shall be at liberty to reject any defective welds to be cut and re-welded.

 The Owner/PMC shall have free access at all reasonable times to all places where the contractor at the contractor’s expense with all the necessary facilities and labour for inspection during fabrication and erection. The Owner/PMC and his authorised representative shall be at liberty to reject in whole or part of any work or material that does not conform to the terms of these specifications, and may order the same to the remove, replaced or altered at the expense of the Contractor

 The contractor shall be responsible for every piece being made to the correct form and size notwithstanding any inspection of any of the contractors working shop drawings by the structural engineers / Owner/PMCs.

 The contractor shall keep the Owner/PMC informed of the fabrication programme and shall permit the Owner/PMCs or his representative full access to his works, at reasonable hours, for the purpose of inspecting the steelwork at any stage in its manufacture. Any materials not complying with his specification shall, upon inspection, whether at his works, the site, or erected in position, be rejected and it shall promptly be rectified or replaced to the entire satisfaction of the Owner/PMC.

 **Safety**

 In erecting steel work note shall be taken of the recommendations mentioned in the clause of IS “Code of Practice for Safety and Erecting Structural Frames” to ensure safe erection of the structural frames.

 Throughout the erection of the structure, the steel work shall be securely bolted or fastened in order to ensure that it can adequately withstand all loading liable to be encountered during erection including, where necessary, those from erection plant and its operation. Any temporary bracing shall be left in position until such time as erection is sufficiently advanced as to allow it’s safe removal.

 Contractor has to provide to all concern team members, safety wearing accessories including eye protection goggles, hand gloves, safety shoes, safety helmets, safety belts etc, as mentioned in the relevant safety clause.

 **Protection:**

 All other elements of the building or adjacent building shall be protected during erection of the structural steel works. In particular steel work shall not be stored on parts of the building without the approval given by the Owner/PMC in writing’s.

 **Tolerances**

 **Testing and Sampling**

 The Owner/PMC at his discretion may select samples from the work at any stage of its completion for the purpose of testing for chemical analysis, for impact tests, Dye Penetration test or any other testing that the Owner/PMC may require. The contract shall carry out all the testing as instructed.

 Where butt welds occur in any portion of the work which are likely to be subjected to tensile stress in the completed works the contractor shall arrange and pay for radiographic tests to be made of all such butt welds by an approved independent tester. The radiographs shall be readily identifiable with the weld it is related to and shall be submitted to the engineer for examination and retention.

 Where butt welds occur in any portion of the work which are likely to be subjected to compressive stress in the completed work the contractor shall arrange and pay for radiographic tests as described above for 10% of such weldments and the Engineer shall direct which joints shall be so tested.

 In addition to the testing described above, the Owner/PMC may require further testing of weldments or any of the materials used to be carried out by an independent tester, either in his works or on the site.

 **Marking and Dispatching:**

 The work shall be dispatching in such portions as may be found convenient for erection or as ordered by the Project Engineer and shall be unloaded and stacked only in the allowed space.

 **Primer coat of painting on steel work:**

 The whole of steel work except where encased in concrete and excepting edges and adjacent surface areas to be field welded, before being despatched from contractor’s shop shall be dry and after being thoroughly cleaned free from rust, mill scale dust etc. to the satisfaction of the project engineer and shall be given two coats of zinc chromate paint unless otherwise indicated. Paint shall be applied by brush and not by cloths/ rags.

 **Blasting**

 After fabrication all items of steel work shall be cleaned such that it is free from grease and other deleterious matter. After cleaning, all items of steel work, including bolted interfaces, shall be blast cleaned at works to 2nd quality finish as defined in IS codes. The maximum profile height of the blasted surface shall not exceed 50 microns.

 All surface defects, including cracks, surface laminations and pitting, shall be removed as laid down in IS 1477. All fins at saw cuts, burrs, sharp edges, weld spatter, slag, flux and extraneous weld metal shall be similarly removed. Where extensive grinding has been necessary, the dressed area shall, be re-blasted to provide the surface specified. After blasting, the substrate shall be vacuum cleaned to remove all; spent shot, grit, dust or other debris. The substrate shall also be free from moisture, oil or any other deleterious material.

 Immediately after blast cleaning is complete, and in any case within four hours, the steel work shall be protected by the application overall of one coat of zinc chromate primer. A second coat of Zinc chromate primer shall be applied when the first coat has attained a hard finish, but in any case shall not be applied within 16 hours of the first painting.

 **Masking**

 Any areas of steel to be site welded or contact surfaces in friction grip bolted assemblies shall be carefully masked off from the priming coats.

 Care should be taken when storing, transporting and erecting the primed steel work to protect the painting and to minimise mechanical damage.

 **Zinc chromate primer**

 After erection, site bolts and any damaged area shall be made good by the contractor by thorough had cleaning down to bare metal and degreasing. These areas shall then be stripe painted with two coats of zinc chromate primer. Paint coatings shall not be applied in adverse ambient conditions.

 The complete paint system shall be purchased from one paint supplied upon his recommendations that each part of the system is compatible with the remained and that the complete paint system is satisfactorily resistant to the environment envisaged for the structure. Thinners shall only be used strictly as and when recommended by the paint supplier. The paint system to be employed shall comprise the coatings, each of a different colour, as listed in the following sub clauses and each coating shall be applied in strict accordance with the manufacturers printed recommendations.

 All steel work shall be shop painted with two coats of Zinc Chromate primer which shall comply with the requirement of IS 1477. Each coat shall have a dry film thickness (DFT) not less than 35 microns.

**Unloading Stacking and Storage**

 All structural steel members brought by / handed over to the contractor shall be handles with care, stacked on edge and supported evenly.

 Fabricated parts shall be handled and stacked in such a manner than permanent damage is not caused to the components. Means shall be provided to minimise damage to the protective treatment on the steel work and any damage which does occur shall be made good.

 All work shall be protected from damage in transit. Particular care shall be taken to stiffen free ends, prevent permanent distortion, and adequately protect surfaces. All bolts, nuts, washers, screws, small plates and small articles generally shall be suitably packed and identified.

**Erection:**

 Erection Program:

 Erection program shall be submitted for approval of Owner/PMC and only upon the approval the erection shall be carried out. Erection of the steel work shall be carried out in accordance with the recommendations of Indian Standards “Code of practice for safety in erecting structural frames” and standard engineering practices.

 Details of the weight and location of any lifting, erection or other machinery shall be submitted to the Owner/PMC for comment prior to such machinery being brought on to site.

 The site welding procedures proposed by the contractor shall be submitted to the Owner/PMC for comment before work proceeds on site and shall be as per recommendations for site welding and cutting given in IS codes.

 **Approval of Site Connections:**

 In order to facilitate handling transportation, and execution, the contractor may fabricate the structural members in suitable sections. The details of the site connections and their locations shall be approved by the Owner/PMC.

 Frame or lattice sections intended for use as parts of composite construction, which are likely to defect considerably during handling, shall be suitably stiffened by means of steel angles. Roof and other structures shall be supported at close intervals during the welding bolting of site connections.

 **Adequacy of Temporary connections, Bracings:**

 As erection progresses, the work shall be securely bolted up, or welded to take a care of all dead load, wind erection stresses.

 The contractor shall be responsible for the suitability, safety and capability of all plant and equipment used for erection.

 Throughout the erection of the structure, the steel work shall be securely bolted or fastened in order to ensure that it can adequately withstand all loading liable to be encountered during erection, including, where necessary, those from erection plant and its operation. Any temporary bracing shall be left in position until such time as erection is sufficiently advanced as to allow its safe removal. All connections for temporary bracing, bolts, members, etc, to be provided for erection purposes shall be made in such a manner as not to weaken the permanent structure or to impair serviceability. All plant used by the contractor shall be sufficient for the purpose of erecting the steelwork.

 The contractor shall be entirely responsible for the stability of the structure during erection and shall arrange that sufficient tack bolts are used to ensure that the work will remain rigid until final bolting is completed. The contractor shall supply and fix, without extra charge, any temporary bracing which may be necessary. Final bolting is to follow on as soon as possible in order to keep the amount of tack-bolted work to a minimum. Fabrication shall be such that all parts can be accurately assembled and erected. Drift pins shall be employed only to align such parts and must not distort the work.

 The frame of steel skeleton buildings shall be carried up true and plumb, and temporary bracing shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including equipment and the operation of same. Such bracing shall be left in place as may be required for safety.

 **Alignment**

 Alignment of each part of the structure shall be carried out as soon as possible after it has been erected. Permanent connections shall not be made between members until sufficient of the structure has been aligned, levelled, plumbed and temporarily connected to ensure that members will not be displaced during subsequent erection or alignment of the remained of the structure.

 When the steel work has been finally levelled and plumbed the space under all base or bearing plates shall be thoroughly cleaned, dampened and then grouted, as described under the specification for concrete work.

 No riveting or welding shall be done until as much of the structure as will be stiffened thereby has been properly aligned.

 **Cambering:**

 Required camber of trusses shall be shown on the erection diagram. If camber involves the erection of any member under a straining force, this shall be noted on the erection diagram.

 **Straightening Bends:**

 Slight bends in the members of fabricated structures shall not be straightened unless strictly necessary on account of the danger of over straining connections and rivets, welds of bolts. Connection plates, if slightly bent or twisted, shall be straightened cold, if bent so sharply as to require heating, the whole piece thus heated shall be subsequently annealed. No straightening whatsoever shall be carried out without the previous sanction of the Architect.

 **Damaged Parts:**

 Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be painted in distinctive colour. Such material is to be dealt with expeditiously under the orders of the Structural engineers.

 **Expansion Gaps:**

 Particular care must be taken to ensure free expansion and contraction wherever provided, for in drawings or special specifications.

**Painting of Structural Steel Work:-**

All the members of the structures shall be painted with two coats of Zinc chromate primer at work shop prior to dispatch to site as explained herein above.

 **Painting joints:**

 The surface of all joints must be thoroughly scrapped and then painted with a thick coat of Zinc chromate before jointing up, which should be done while the paint is still wet. This procedure shall not be apply to welded joints.

 Care must be taken to see that all the component parts fit, correctly according to distinguishing joints or match marks. No interchange pieces shall be made, unless absolutely necessary to avoid chipping and filling, or serious delay. For such interchange of pieces specific prior approval of the Architects, is necessary.

 Final painting

 Notwithstanding anything contained in section 11 for painting the final painting of the structural steel work shall be treated as per this clause.

 Final painting of the structure shall not be done till such time as the structural engineer / Owner/PMCs / Architect has satisfied himself that the riveting, and bolting has been completed in a workmanlike manner and all defective joints have been replaced.

 Touch up and make good damaged priming coats as defined above. Apply one coat of high build Zinc Chromate paint. (Min DFT = 50 Microns). Apply one coat of decorative gloss paint. The nominal dry film thickness of the completed system, excluding the decorative gloss, shall be in the range of 170 to 190 microns.

 Steel to be encased in concrete shall be despatched from works unpainted, but mill scale and loose rust shall be removed prior to delivery to site. After erection, the steel shall be free from any contamination of dirt, oil or grease.

 After erection is completed, the entire structural steel work shall be painted two coats as indicated of approved quality shade and make and as per the colour schemes specifications on the drawing or as directed by the Owner/PMC.

 The job shall be carried out in workman like manner, all corners shall be painted carefully. The painting operation shall conform to IS 1477. Before painting, all loose scales, and dust shall be removed. The colour coat shall be laid evenly, properly with brushes of approved quality and make. Each coat of colour shall be allowed to dry thoroughly before the next is laid on. No hair marks from the brush shall be left on the work.

## Specification for Demolition And Dismantling

 **Scope**

This specification covers the procedure and safety requirements for demolition and dismantling of masonry (Brick & Stone), concrete (Plain/Reinforced), structural steel (sheeted/ unsheeted) works.

  **General**

Apart from this specification, the demolition and dismantling of structures (part or whole) shall be in compliance with all statutory safety regulations and any other special requirement and General Conditions of Contact. Prior consent and approval of the Owner/PMC shall be obtained in writing before starting any dismantling works. Any restrictions imposed regarding working hours shall also be strictly followed by the Contractor.

All materials obtained from dismantling/demolition operations shall be the property of the Owner unless otherwise specified and shall be kept in safe custody until handed over to the Owner/PMC.

Where it becomes necessary to disconnect any existing service line(s) (such electrical, piping etc.) during dismantling/demolishing operation and where so required by the Owner/PMC, suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service line(s) with the approval of the Owner/PMC at no extra cost to the Owner.

Relevant clauses of this specification for Earthwork shall be referred to the extent applicable.

 **Safety Precautions**

The Contractor shall adhere to safe demolishing / dismantling practices at all stages of work to guard against accidents, hazardous and unsafe working procedures.

Necessary propping, shoring, strutting and/or underpinning shall be done for the safety of all surrounding structures (whose safety is likely to be endangered) before taking up the demolishing and dismantling work.

Temporary enclosures made our of GI sheets, fencings, danger lights etc. shall be provided by the Contractor and got approved by the Owner/PMC before start of work to prevent accidents.

Contractor must ensure the availability of adequate firefighting equipment / arrangements before starting actual demolishing / dismantling works. These facilities shall be made available throughout the entire operation of demolition and dismantling structures.

All equipment, pipes, fittings and instruments, underground utilities etc. located in the vicinity shall be protected by suitable means, as decided by the Owner/PMC, during demolishing, dismantling operations.

Roads and working spaces shall be kept free of any debris/dismantled materials at the end of day’s work.

Necessary measures shall be taken to keep the dust and noise nuisance to minimum levels.

Dismantled elements/components shall not be dropped from a height or thrown from a distance. Dismantling of elements fixed by screws/bolts/hooks etc. shall be done by taking out the fixtures with proper tools only. Such fixtures may be allowed to be cut by sawing or flame cutting, in the event of their being stuck-up due to corrosion etc. however the decision of Owner/PMC in this regard shall be final and binding. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any conditions.

 **Procedure**

Entire work of demolishing and dismantling shall be meticulously planned. Prior to start of work, the Contractor shall thoroughly understand the scope of nature of the work, and then prepare and submit the proposed work execution plan of demolishing and dismantling to the Owner/PMC for his review. Comments, if any, shall be taken care by the contractor and execution of the work shall be done based on the revised execution plan.

Demolition and dismantling shall be restricted to as directed by the Owner/PMC.

Demolition of any structure shall be carried out in the sequence reverse so that followed at the time of its construction.

Dismantling shall be done in a systematic manner. All elements shall be carefully removed without causing any damage.

Blasting in any form shall not be permitted.

Chipping of concrete/grout shall be done with precision by chiselling. The finished surfaces shall be made true to the requisite size and shape.

Pockets/holes of specified size shall be made/cut by drilling/chiselling.

 **Cleaning & Stacking**

All demolished/dismantled serviceable materials such as bricks, stones, reinforcement bars, structural steel, sheeting etc. shall be separated out, cleaned and stacked in separate lots within the plant boundary for dumping of disposed material shall be arranged by the contractor and got approved by the Owner/PMC.

 **Disposal**

All unserviceable materials shall be disposed off in spoil heaps within or outside the plant boundary as per the directions of the Owner/PMC. Areas required outside the plant boundary for dumping of disposed material shall be arranged by the contractor and got approved by the Owner/PMC.

## Specification for Bonding Fresh Concrete to Old Concrete by Epoxy Resin Bonding System.

**Scope**

This specification defines the material, constructional and other performance requirements for proper bonding of fresh concrete to old, hardened concrete by epoxy resin bonding system which is able to cure under humid conditions and bond to damp surfaces. Any special requirement as shown or noted on the drawings and directed by the Owner/PMC shall govern over the provisions of this specification.

Actual working shall be carried out in accordance with this specification and recommendation of the manufacturer of the resin system to suit specific requirements for the particular site and other climatic conditions existing there. In case of any conflict, this specification shall govern.

**Materials**

The bonding material shall be compatible with the concrete to which it is to be applied and shall have the following minimum properties.

Compressive Yield Strength 55N/mm2 (7 days)

Tensile Strength 40N/mm2 (7 days)

Bond Strength 10N/mm2 (14 days)

Pot Life 45 minutes

Full Cure 7 days at 20°C to 35°C

Overlaying Time (open time) 1 Hr.

The resin and hardener shall be mixed in the proportion as specified by the manufacturer. The preparation, mixing and application of the resin system shall strictly be in accordance with the manufacturer’s recommendations.

Certificate of test results of all the materials from the reputed laboratories duly authenticated by the approved manufacturer(s) shall be submitted to Owner/PMC and got approved by him in writing prior to commencement of work. In the event of failure to submit such test results from the manufacturer for any material, the contractor shall carry the tests from an approved laboratory and submit the test results including the name(s) of manufacturer(s) to the Owner/PMC and get approved by him in writing prior to commencement of work. All tests shall be in accordance with ASTM-C-881-90 in case of non-availability of any specific Indian Standard.

**Special Requirement**

All works covered by this specification shall be carried out by experienced and approved agency having sufficient knowledge in epoxy resin treatment works. Only skilled and experienced operators shall be employed for the purpose.

**Application**

**Preparation of Concrete Surface**

 Grease, oil, algae and other foreign substances likely to impair good bonding shall be thoroughly removed from the surface by scrubbing or using detergent and washing with clean water. All loose and spalling concrete pieces shall be removed. The surface to be bonded shall be made thoroughly rough by chiselling, taking off the skin of concrete and sharp edges of aggregate shall be exposed. The surface shall be washed, wetted cleaned and dried with dry compressed air. Exposed reinforcement shall be thoroughly cleaned with sand paper and wire brushes to remove all dust and sticking mortar.

**Mixing**

 The resin and hardener shall be thoroughly mixed in a mixer. The approved resin system shall be prepared strictly as per manufacturer’s recommendations. It shall not contains lumps and shall have uniform colour. Filler material shall be added if so specified by the manufacturer. Hand mixing shall be allowed for small quantity with prior permission of the Owner/PMC.

**Method of Application**

 The resin system shall be applied by spraying to the prepared surface. Manual application by using stiff nylon bristle brush may also be allowed with prior permission of the Owner/PMC. The manufacturer shall specify the method of application suitable for the specified work.

**Coverage**

 A minimum of half kilogram per square metre (0.5 kg/m2) or resin system shall be applied to prepared concrete surface. However, the covering capacity depends on the nature of surface over which the system is being applied and the contractor shall use additional quantity of the resin system as per the recommendation of the manufacturer.

**Handling Precaution**

 Only skilled and experienced workers shall be entrusted with the application of epoxy system. The resin and hardener shall not be allowed to come into direct contact with the skin. Rubber or polythene gloves with cotton gloves underneath must be worn by the workers handling resin products. Parts of skin which have accidently come into contact with resin or hardener shall immediately be washed with lukewarm water and a mild soap. Special cleaning creams or chemical shall be kept readily available and used as recommended by the manufacturer.

**Cleaning and Maintenance of equipment**

 Tools and mixing equipment shall be cleaned immediately after use by using scrapers and other solvents (e.g. toluene, xylene or acetone) as recommended by the manufacturer.

A**PPROACH, WORKING PLATFORM & SCAFFOLDING**

The contractor shall arrange all approaches, stairways, ladders, working platform etc. for carrying out the entire operation safely. The working area shall be neatly maintained and all facilities required by the Owner/PMC for proper supervision of the work shall be provided by the contractor.

All precautionary measures required for the safety of the structure during the progress of operation and till the successful completion and handing over shall be the responsibility of contractor. He shall carry out all such measures as directed by Owner/PMC.

**SECTION D 3 – Architectural & Interior Works**

## General

All materials shall conform to the latest edition of the Indian Standard Specifications. Standards issued elsewhere may be used only if approved by the Owner/PMC and for those materials only for which appropriate Indian Standards do not exist.

If specification for any material/work is not available in these Technical Specifications, the material/work shall conform to the latest CPWD Specifications, with up to date correction slips, amendments and additions. The work shall be carried out in general as per the latest Central Public Works Department (CPWD) specifications with up to date correction slips, amendments and additions/IS CODES/Manufacturers specifications/as per drawings/as per instructions of Owner/PMC/Employer.

## Scope

This specification applies to the Civil, Finishing of Buildings and scope under External Area Development Works to be executed by the Contractor. It is to be read in conjunction with and subject to the general conditions of contract and in conjunction with the drawings, and such other documents as may from time to time be agreed upon as comprising part of this contract. Where these specifications are not clear, relevant codes and specifications shall be followed with prior permission of Owner/PMC.

The Project is to conform to green building and targeted for LEED Gold rating all the methods of construction and measures adopted during construction and materials and specifications have to be in accordance of the LEED Goldrating requirements. Any make / material specified but not conforming to LEED Goldrating shall be replaced under approval of Consultant / Owner/PMC and nothing extra shall be payable to the Contractor in this regard.

1. **Clearing**

 The contractor shall clear the site of all rubbish and temporary structures, remove all grass and low vegetation and remove all bush wood, trees, stumps of trees, and other vegetation only after consultation with the Owner/PMC as to which bushes and trees shall be saved. All disused foundations, drains or other obstructions met with during excavation shall be dug out and cleared.

1. **Site Levels**

The contractor shall carry out the survey of the site and shall establish sufficient number of grids and level marks to the satisfaction of the Owner/PMC, who shall decide on the basis of this information, the general level of the plot and the plinth.

1. **Bench-Marks**

The contractor shall inspect the site, If desired so, prior to commencement of construction, the contractor shall in consultation with the Owner/PMC, establish additional site datum bench-marks, upto his satisfaction. Nothing extra for any of the above shall be paid to the Contractor and the rates quoted by Contractor will deemed to have included the above costs.

1. **Site Investigation**

The contractor has to carry out the “Geo Technical Investigation” for completeness and adequacy for the design works. The contractor shall perform the investigations on his own as per the design requirements at no extra cost payable and shall carry out geotechnical investigation with bore hole drilled upto 30m or such a depth as given in IS 1893 Part 1.

Also the same shall be vetted by specialist Geo Consultants and any additional investigations required for the same shall be done by the Contractor at no additional cost to the Employer.

1. **Setting out the Work**

The contractor shall set out the works and during the progress of the building shall amend at his own cost any errors arising from inaccurate setting out.

During the execution of the work contractor must cross check his work with the drawings. The contractor shall be responsible for all the errors in this connection and shall have to rectify all defects and/or errors at his own cost, failing which the Owner/PMC reserves the right to get the same rectified at the risk and cost of the contractor.

1. **Cleaning Up and Handing Over**

Upon completion of the work all the areas should be cleaned. All floors, doors, windows, surface, etc. shall be cleaned down in a manner which will render the work acceptable to the Owner/PMC. All rubbish due to any reason, shall be removed daily from the site and an area of up to ten metres on the outer boundaries of the premises will be cleaned by the contractor as a part of the contract.

1. **Samples**

The contractor shall submit to the Owner/PMC samples of all materials for approval and no work shall commence before such samples are duly approved. Samples of, masonry units, building insulation, finished hardware, metal window, door frames and shutters, flooring tiles, stone, marble, granite, all finishing materials, glass, concrete pavers, paver tiles, etc. and every other work requiring samples in the opinion of the Consultant/ Owner/PMC shall be supplied to the Owner/PMC, and these samples will be retained as standards of materials and workmanship. The cost of the samples shall be borne by the contractor.

Throughout this specification, types of material may be specified by manufacturers' name in order to establish standard of quality, price and performance and not for the purpose of limiting competition. Unless specifically stated otherwise, the tenderers may assume the price of 'approved equivalent' except that the burden is upon the contractor to prove such equality, in writing.

A detailed programme shall be submitted by the Contractor for the material approvals, within stipulated timeframe finalised by Owner/PMC. The same shall be reviewed and approved by Consultant / Owner/PMC. The detailed programme shall include but not limited to:

1. Date/s of submitting the various material samples.
2. Date/s by which the Owner/PMC approval is required.
3. Date/s of placing orders on the Manufacturers/Suppliers.
4. Date/s of arrival of the approved material/s on to the site.
5. Date/s of the completion of the `Mock-ups', wherever required, and the Date/s by which the Consultant /Owner/PMC/ Employers inspection of such `Mock-ups' should be completed and the Date/s by which the Owner/PMC should fully approve the said Mock ups.
6. All the above shall be linked with the project master construction program and procurement schedule.
7. **Tests**

A Quality Assurance Plan(QAP) shall be finalise by Owner/PMC/ Employer & Contractor before start of the work. QAP shall be based upon IS codes/CPWD specification/BS/ Section 7-Volume -II of the Tender document and good engineering practice to decide various material for testing/ method of testing and their frequency and various format for quality control to be adopted. Once QAP is finalise, all the materials need to be tested accordingly and if results are not as per the desired result than such materials shall be rejected. All the test shall be done at govt approved testing facilities and cost shall be borne by contractor. The testing facilities shall be approved by Consultant / Owner/PMC before any sample is being sent for testing.

1. **Making Good**

The contractor shall cut, leave or form holes, recesses, chases etc., in concrete, MASONRY work, walls, ceilings, floors and in any other situations as required or as directed by the Owner/PMC and make good in cement and sand mortar (1:3)/PCC (1:2:4) as decided by Owner/PMC and finish to match the adjoining surfaces. No extra payment shall be admissible in this regard.

## Drip Course

Drip course in PCC cills/ Projections etc. shall be provided at all places irrespective of as shown in drawings.

## Plinth Protection

The width of plinth protection shall be as shown on drawings. If width is not shown, it shall be 900/1000mm. Plinth protection shall be 75mm thick in cement concrete (1:3:6) over 75 mm thick hard core of 40 mm graded stone aggregate and well compacted over rammed earth and shall be finished with granite. Plinth protection shall be laid to a slope of 1 in 24. The toe of plinth protection of size 75 mm deep and 75 mm wide shall also be of PCC 1:3:6 type C2 and shall be provided in building irrespective of whether shown on drawings or not. Plinth protection shall be provided to all buildings irrespective of whether shown on drawings or not.

## Damp Proof Course

Damp proof course with 40 mm thick pcc (1:2:4) shall be provided on all masonry walls and masonry pillars for their full length and width at the ground floor where there is no basement underneath and at the basement floor. Damp proof course shall also be provided under openings/door opening at depressed level including vertical faces of depressed level and including vertical faces of depressed portion of opening as per requirement of IS codes. However damp proof course shall not be provided over dwarf walls / rcc columns.

## Splash Stone

It shall be provided for each stack of rain water pipes and shall consist of 75mm thick PCC M20 nominal mix using 20mm aggregate over 75mm thick well compacted hard core all as specified and shown on drawings. The top surface shall be prepared even and smooth using extra cement.

## Mirror Finish Granite Stone Over PCC Sill

PCC sill (1:2:4) shall be provided at places where shown on drawings all as per typical details given in drawings. However, irrespective of being indicated on drawings or not, the top of window sills inside portion shall be provided with 18 mm thick polished Granite stone slab with mirror finish in one piece. Granite stone slab shall be provided over 20 mm thick screed of cm (1:6). Top of Granite stone sills shall be flush with external portion of P.C.C. sills and shall finished half round as shown in the drawing.

## PCC Coping

PCC coping (1:2:4), 50 mm thick, using 20 mm graded stone aggregate shall be provided on all walls / column tops.

## Plinth Band/Beam

RCC band/beam as specified/ shown on structural drawings shall be provided at plinth level throughout including doors and other openings and in locations shown on drawings. The concrete mix shall be mixed with the integral water proofing admixture of make as specified in respective appendix attached to these specifications in the proportion as recommended by the manufacturer with a coat of bitumen grade 85/25 conforming to IS codes @ 1.5 Kg per Sqm on top. Thickness and reinforcement of plinth band shall be as shown on drawings. Where these have not been shown on drawings thickness shall be 80mm and longitudinal bars shall be 2 Nos of 12 mm TMT bars and links shall be 8mm bars @ 150mm C/C.

## Expansion Joints

## 10.1 Expansion Joints: Horizontal & Vertical

Following procedure shall be followed to treating the expansion joints of roof and walls. ·

The expansion joints shall be thoroughly cleaned including chipping of existing mortar, thermocol / shalitex board etc. up to a depth of 200 mm.

The expansion joint shall be treated up to a depth of 200 mm filled with polysulphide sealant (gun grade) with polystyrene board (thermocol sheet) of 50 mm thick and width of expansion joint as a backing material. Polysulphide sealant (gun grade) Shaliseal PS GG of STP ltd shall be applied over the thermocol sheet to have a watertight surface.

Place 1 mm thick aluminum sheet over the expansion joint with minimum 75 mm on either side of the expansion joint.

One side of the aluminum sheet shall be screwed to the concrete surface and the other side of the aluminum sheet shall be free to move.

One layer of EPDM membrane shall be fixed on the surface of the aluminum sheet and concrete with minimum 75 mm width of sheet glued to the concrete surface.

A compressible tube (Polyurethane rod) of diameter equal to the width of the expansion joint shall be placed in position. The PU rod is placed to allow for excess length of the membrane across the expansion joint. The expansion joint is then covered with second layer of EPDM membrane / Tarfelt APP membrane of approved make over the PU rod with minimum 75 mm width of sheet glued to the concrete surface. Enough extra length of membrane is ensured to accommodate building movement. ·Necessary Waterproofing shall be carried out over this treatment. 25 mm thick cement mortar screed shall be provided over the EPDM membrane / Tarfelt APP membrane of approved make. To prevent shrinkage cracks in mortar, polyester fibers shall be added in the cement mortar screed with a dosage of 0.25 % of weight of cement used. A geo textile polyester membrane (200 gsm) shall be provided between EPDM membrane / Tarfelt APP membrane of approved make and cement mortar screed for the protection of water proofing membrane.

The top of the finished surface shall match with the top surface of the slab for easy movement of rainwater / movement of vehicles.

## Road Works

Cement Concrete Pavement Under Controlled Conditions

Materials- Cement

1. Cement used on work shall be as per sub head cement concrete of CPWD specifications- 2019 (Vol. – I).
2. Water: Water used on work shall conform to SH: cement concrete of CPWD, Specification 2019- Vol. I.
3. Coarse Aggregate: These shall be crushed or broken from hard stones obtained from approved quarry. These shall be clean strong, durable of fairly cubical shape and free from soft, friable, thin elongated and laminated disintegrated pieces. These shall also be free from dirt, organic deleterious and any other foreign matter and adherent coatings and shall satisfy the physical requirements laid down in para 16.37.19 under quality control conforming to CPWD Specification 2019 Vol. II

This shall be coarse sand conforming to CPWD Specification 2019 Vol. I.

1. Grading of Mixed Aggregates:The grading of all aggregates (coarse and fine aggregates) to be used in the work shall be determined in the laboratory. The coarse and fine aggregates shall be mixed in suitable proportions so that the grading of the mixed aggregates shall be in the range indicated in Table below.

**Table 16.32**

*I*.S. Sieve Size (IS 460) % age passing by weight

45 mm 100

22.4 mm 55 - 60

11.2 mm 45 - 50

5.6 mm 35 - 40

2.8 mm 30 - 35

1.4 mm 20 - 25

710 microns 15 - 20

355 microns 10 - 14

180 microns 2 - 5

**Mix Design**

The mix shall be approved by Engineer-in- Charge so as to obtain the following mean strength that exceeds the minimum specified flexural strength by 1.64 times the designed standard deviation.

Minimum works beam flexural strength at 28 days = 300 kg/sqm. for M-30 or specified in item

Designed standard deviation = 60 kg/sqm. for M-30 or for specified grade(s)

Design flexural strength at 28 days = 300+60x1.64

Water cement ratio by weight = 398.4 kg/sqm. (f + 1.64 s) says 400 kg.

Water cement ratio by weight = 0.5

Minimum slump not more than 25 mm

For the purpose of tendering the contractor shall base his rate on the assumption that the quantity of cement used for one cum. of finished concrete shall be 340 kg. or M - 30. If the actual quantity of cement required to be used as a result of the laboratory test is different from that assumed above, necessary adjustment in the cost due to short cement used shall be made on the basis of issue rate of cement including storage charges plus 2.5% for handling charges. However, under no circumstances the quantity of cement to be used shall either exceed 350 kg./cum or fall below 330 kg. per cum of finished concrete.

**Statistical Field Check**

Samples of concrete shall be taken at the mixer and works beams, made, cured and tested in accordance with IS 1199 and IS 516.

When a mix is used for the first time, it is important to get a large number of results, as soon as possible, in order to establish the level of control and then suitability of the mix proportions.

A sample of concrete shall be taken at random on eight separate occasions during each of the first five days of using that mix. From each sample two beams shall be made one for test at 7 days and the other for test at 28 days.

The work beam results shall be examined both individually and in consecutive (but not overlapping) sets of four, for which the average and the range of each set is calculated. The mix proportions shall be modified to increase the strength, if in the first ten consecutive (but not overlapping) sets any of the following conditions are not satisfied.

(I) Each sample has test strength not less than the minimum specified strength i.e. 30 kg/sq.

cm. (or otherwise specified in item).

OR

(II) (a) Not more than two individual results (Not more than one of first twenty) of the 40 beams tests shall fall below the minimum work beam strength but they shall not be less than

80% of the specified beam strength of 30 kg./sq. cm (or otherwise specified in item) or the minimum specified strength minus 1.35 times the standard deviation whichever is greater.

(b) No value of the range in any set shall exceed 3 times the designed standard deviation.

(c) The average for all samples (10 sets) shall not be less than the minimum specified strength i.e. 30 kg/sq. cm (or otherwise specified in item) plus 1.64 times the designed standard deviation 60 kg./sq.cm M-30.

If either of these conditions as above are not satisfied, the mix shall be modified and the procedure described above shall be repeated till results satisfying the above criterias are obtained.

**Slump Test**

The test shall be carried out as per IS 1199. A slump test shall be carried out at each mixer at least one in fifty batches mixed or more frequently if directed by the Engineer- in-Charge. Any batch from which slump test is being made shall not be transferred to the place of laying till the slump test has been completed. Not only the batch which gives a slumps in excess of that specified shall be rejected but the concrete already laid immediately preceding the batch tested upto the nearest last transverse joint may be rejected by the Engineer-in-Charge or his subordinate, if he is satisfied that such preceding batches were substandard in this respect. The decision of the Engineer-in-Charge in this respect shall be final and binding on the contractor. Such rejected concrete shall be removed by the contractor immediately and replaced with proper slump concrete at his cost and expense.

**Batching and Mixing**

As detailed in SH: 5 of reinforced cement concrete work of CPWD specifications 2019.

**Placing of Concrete**

As detailed in SH: 5 of reinforced cement concrete work of CPWD specifications 2019.

**Compaction of Concrete**

Compaction shall be carried out by electrically (or) diesel operated needle and screed vibrators as stipulated hereafter. Needle vibrator should be used all over the area for obtaining initial compaction of concrete. These should be of diameter not less than 4.5 cm. If the vibrators are pneumatic the pressure must not be below 4 kg/sq.cm. If electrically operated, they should have a minimum frequency of 3500 impulses per minute.

There should be at least three needle vibrators working in any bay. A vibrating screed consisting of a steel or timber section weighing not less than 15 kg. per metre with a tamping edge of not less than 7 cm width and having a vibrator mounted thereon shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with M.S.

Plate rigidly fixed by means of counter sunk screw. Where screed vibrators are used for compaction, a standby unit shall always be maintained ready for use, should the other one go out of order. Where electrically driven vibrators are employed, a standby diesel pneumatic unit shall be kept ready for use in case of power failure. At the discretion of the Engineer-in-Charge, for compaction at edges and joints, vibrators may be supplemented by hand tamping and rodding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

When using screed vibrator for compaction it should not be dragged over the concrete.

During the initial passes it shall be lifted to the adjacent forward position in short steps, subsequently, it shall be slowly slided over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained.

Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints.

Concrete shall be deposited on the base as near the joints as possible without touching them. It shall then be shoveled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of the joints, care being taken that it is worked well around the joints.

The concrete shall not be dumped from the bucket directly upon or against the joints.

Workmen shall not be allowed to walk on freshly laid concrete and proper cat walk shall be provided with independent supports beyond concreting bays.

**Finishing of Concrete**

During compaction, any low or high spots shall be made up by adding or removing concrete.

After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished.

Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished.

The straight edge testing the refloating is to continue until the entire surface:

1. is free from observable departure from the straight edge,
2. conforms to the required levels and across section, and
3. shall conform to the specified surface when the concrete has hardened.

The foregoing work is to be carried out while the concrete is still plastic and workable.

**Brooming**

After belting and as soon as the surplus water, if any, has risen to the surface, the pavement shall be given a broom finish with an approved steel or fiber broom not less than 45 cm wide. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavementand so executed that the corrugations formed shall be uniform in character and width and not more than 1.5 mm deep.

Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions, and small pockets such as may be caused by accidental disturbing of particles of coars.

**Surface Accuracy**

After the concrete has sufficiently hardened after about 12 hours and not later than 24 hours, the surface shall be tested again for high spots. All high spots shall be marked and those exceeding 3 mm shall be ground down immediately. Care shall be taken to see that the grinding does not in any way damage the concrete surface.

The final surface finish is to be such that when tested with a profilograh /roughness indicator/or a 3 metre long straight edge or an equivalent mechanical unevenness indicator placed anywhere within the same or adjoining slab in any direction on the surface, there shall be no variation greater than 3 mm.

If the surface irregularity exceeding 3 mm still remains despite grinding as per para 16.37.13.2 the concrete shall be removed to its full depth. The area of concrete to be removed shall be complete slab between the nearest joints, where the defective slab is less than 4.5 metres from the expansion joint, the whole area upto the expansion joint shall be removed to the full depth. The concrete so removed shall not be reused in the work. Fresh concrete shall be laid in the manner already de-scribed in above paras and shall again be subject to test for surface accuracy and other quality control measures. Nothing extra shall be paid on this account.

**Construction Joints**

Construction joints shall be provided as shown in the drawing and also at places where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full thickness of the slab. While concrete in adjacent bay is still green, flats of suitable size shall be drawn along the edge and a groove of size 10 mm × 25 mm deep shall be neatly formed and finished. The edges of the groove shall be full nosed. After curing of concrete is complete, this groove shall be thoroughly cleaned of all sand dust and shall be perfectly dried and filled with hot poured sealing compound conforming to grade B of IS 1834. Before filling with sealing compound the faces of concrete of the joint shall be coated with primer of approved brand to a depth of 25 mm at the rate of 2.6 liters per 10 square meters. Bitumen emulsion shall not be used as primer.

**Dummy Joints**

The joints shall be 10 mm wide and shall extend vertically from the surface of the slab to a depth equal to 1/3rd of the thickness of the slab but not less than 4 cm in any case. The joint may be formed by depressing into the soft but compacted concrete a high tensile M.S. or other approved.

Tee of flat bar of depth not less than required depth of the joint plus 25 mm. The bar used for forming the groove shall be coated with soft soap or other suitable lubricant to facilitate its removal when the steel Tee or flat is removed joints shall be neatly formed with proper tools and mortar/fine material from the slab itself. No additional cement mortar (rich or otherwise) shall be used.

Cutting or sawing by a saw mounted on a movable frame and driven mechanically shall also be permitted as a method for making the joint. In this case the width may be reduced to 6 mm. any other method for making joints can be followed with the prior approval of the Engineer-in-Charge.

In all cases, except where cutting is done with saw, the joint edges shall be bullnosed.

Care should be taken to see that the edges of the grooves are not damaged.

The grooves shall be filled with hot poured sealing compound conforming to Grade B of

IS: 1834. Prior to filling with sealing compound, the joints shall be cleaned by compressed air and primed with Shalijet primer or equivalent at the rate specified in Para 16.37.16.1

All joints shall be sealed as soon as practicable after 28 days of casting of cc pavement.

Joints shall be sealed flush with the adjacent pavement surface in summer and 3-4 mm below finished concrete surface in winter. The pavement shall be opened to traffic only after joint sealing over the entire pavement. To prevent tackiness or pickup under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge, for which nothing extra shall be paid to the contractor.

In case of sudden rain or storm, the work can be concluded at the dummy joints but these will then be formed as construction joints.

Before sealing of joints, it may be ensured that the groove extends fully across the bay between consecutive longitudinal joints, in the case of transverse joints and is continuous in the case of longitudinal joints. Any concrete or other foreign matter must be removed from the groove.

**Expansion Joint**

**Premoulded Joint Filler in Expansion Joint:** It shall conform to IS 1838 (Pt. I). The thickness shall be 25 mm with tolerance 1.5 mm. and shall be of the maximum available standard length not less than one lane width. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within tolerance of + 10 mm from the intended line of the joint. The depth of board shall be 25 mm less than thickness of slab within a tolerance of ± 3mm so that the top of the board shall be below the surface or will not impead the passage of the finishing straight edge or oscillating beam of the paving machine.

**Bitumine Hot Sealing Compound*:*** The joint sealing compound shall be fuel and heat resistant type complying to grade B of IS 1834. It shall be capable of adhering to the concrete without cracking, spalling and disintegration.

**Construction Procedure**

Expansion joints shall be provided as shown in the drawing and as per directions of Engineerin- Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. The joint shall be 20 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab.

Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove of size 20 mm x 25 mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

Before the curing process is started, the top of expansion joint shall be filled with bitumen sand mixture in order to ensure that no foreign material used in curing enters into the joint.

This filling shall be removed before filling the joints with sealing compound.

For sealing the joints following operations shall be carried out:—

(a) The joints are cleared of any foreign matter to the full depth upto the top of expansion pad with steel spatula.

(b) The joints are blown with compressed air.

(c) Cleaning is done with Kerosene oil.

(d) Priming is done with spray gun @ 2.6 liters per 10 sqm of the surface to be primed.

(e) The primer is allowed to dry completely before pouring the sealing compound.

(f) The sealing compound grade ‘A’ is heated to the required temperature ranging between 155 deg. C to 165 deg. C or to the temperature range specified by the manufacturer. Overheating shall be avoided. Pouring shall be done from vessel with spout in such a manner that the material will not get spilled on the exposed surface of the concrete, any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned.

(g) The filling shall be worked into the joints with hot flats to ensure escape of trapped air.

(h) The filling is then ironed with hot iron. It is recommended that while in summer the joints may be sealed flush with the adjacent pavement surface, in winter the sealing compound may be filled to a depth 3-4 mm below the surface.

(i) The edges of the joints are then cut and trimmed to ensure neat and straight line finish.

(j) To prevent tackiness or pick up under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge (Nothing extra shall be paid for the same).

**Painting Road/ Runways Markings**

Special Ready Mix Road marking paint of approved brand and manufacture shall be used.

The paint shall conform to IS 164. Ready mixed paint as received from the manufacturer shall be used without adding any admixture. During work, if the consistency of the paint gets thick and thinning becomes necessary it shall be done by use of thinner of the approved brand of paint recommended by the manufacturer and with the approval of the Engineer-in-Charge.

The paint shall be brought to the site of work by the contractor in original sealed containers.

The material shall be brought in one lot in adequate quantity to suffice for the entire work.

The material shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty container shall not be removed from the site of work, till the work has been completed and permission obtained from the Engineer-in-Charge.

**Preparation of Surface**

The surface shall be thoroughly cleaned and free from dust. All the dirt, scales, oil and grease shall be thoroughly removed before painting is started. The prepared surface shall be inspected and approved by the Engineer-in-Charge before painting is commenced.

**Application**

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its original container. The paint shall be continuously stirred in the smaller container while applying to runway surface so that its consistency is kept uniform.

The painting shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternatively in opposite direction, two or three times and then finally brushing lightly in a direction at right angle to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Each coat shall be allowed to dry out thoroughly before the next coat is applied.

Earlier applied coat shall be cleaned off dust before the next coat is laid.

No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

No hair marks from the brush or clogging of paint puddles shall be left on the work.

The surface shall ordinarily not be painted until it has dried up completely. Trial patches of paint shall be laid at intervals to check if drying is satisfactory.

The runway marking shall be done in accordance with the drawing unless otherwise instructed by the Engineer-in-Charge.

**Brushes and Containers**

After work, the brushes shall be completely cleaned of paint by rinsing with turpentine. A brush in which paint has dried up is spoiled and shall on no account be reused for painting work. On no account kerosene oil shall be used for washing the brush.

When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth so that they are clean, and can be used again.

## Speed Bumps

The scope shall include providing & fixing of Speed Bump ABS Plastic of nominal Size- 250 x 350 x 50 mm, Capacity-40 Ton.

The Speed Bumps shall be made of Sturdy Plastic, with high resistance to severe impacts and harsh weather conditions. The units shall pre-coloured material (Black/Yellow) with UV stabilizers and studded with reflectors on either side so that they are clearly visible to the motorists during night hours. The subunits shall be interlocking type to make it bind perfectly into a one firm bump. The installation procedure shall be as per manufacturer’s specifications and guidelines.

## Glow Studs

Retro reflective Glow studs shall be provided to supplement road markings, which would improve visibility in night time and adverse weather conditions. Glow studs of size 100x20 mm made of heavy duty body shall be moulded ASA (Acrylic styrene Acryloretrite) or HIP (High impact polystyrene) or ABS having electronically welded micro- prismatic lens with abrasion resistant protective coating as approved by Owner/PMC. The glow stud shall support a load of 13635 kg tested in accordance with ASTM D4280. The slope of retro- reflective surface shall be 35 (+/-5) degrees to base. The reflective panels on both sides with at least 12 cm of reflective area up each side. The luminance intensity should be as per the specification and shall be tested as described in ASTM I: 809 as recommended in BS: 873 part 4 : 1973. The studs shall be and fixed to the Road surface using suitable epoxy/bitumen adhesive conforming to IS, as per procedure recommended by the manufacturer complete and as per direction of Owner/PMC.

The colour of the Road Studs shall be white /yellow as approved by Owner/PMC.

## Precast Concrete Paver Tiles

1. **Material - Fibre reinforced concrete tiles**

The tiles shall fibre reinforced cement concrete cement tiles of nominal sizes such as 20 × 20 cm, 25 × 25 cm and 30 × 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Owner/PMC.. The overall thickness of the tiles shall not be less than 22 mm.

All materials shall be approved by Consultant/ Owner/PMC for size, colour ,shade and texture and shall be laid in a mix of design , pattern and colours as approved by Owner/PMC.

Tiles shall be brought and used from, only one source and of the company as approved, for entire work.

1. **Execution**

Bedding -Before spreading the mortar, the sub-base of the shall be cleaned of all dirt, scum and low materials and then shall be well wetted without forming any pools of water on the surface.

Laying -Before laying the tiles, the tiles shall be thoroughly wetted with water. Neat cement grout of required consistency at 4.4 Kg cement/m2 shall be spread on the mortar bed. The tiles shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope. There shall be no hollows left. The joints shall be of uniform thickness and in straight line as per the pattern.

The surface of flooring shall be checked frequently with a straight edge at least two meters long so as to obtain a true surface with required slope.

While laying, any chiselling which may be required for making the skirting or dado flush with the plaster (and/or other finishes shall be done. Necessary grooves of required size in cm, between plaster and/or (other finishes, dado or skirting (if required) shall be provided. Forming machine-cut/rounded edges gutters, sills, platforms, channels, curbing, etc. if any, if required, shall be provided as per the drawing and design.

In places where full tiles cannot be fixed, the tiles shall be cut to the size and smoothened at edge to give straight and true joints.

After the tiles have been laid, the surplus cement slurry and the joints shall be cleaned and washed fairly deep before the cement hardens.

The day after tiles have been laid, the joints shall be cleaned of all grey cement grout with a wire brush to a depth of about 5 mm. and then grouted with white cement, with or without pigment to match the shade of the topping of tiles. The same cement slurry shall then be spread over the whole surface, laid in a thin coat to protect the surface from abrasive damage and to fill pin holes that may exist on the surface.

All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Owner/PMC

Curing -The flooring shall be kept wet with damp sand or water for seven days. It shall be kept undisturbed at least for 14 days. The grinding shall normally be, commenced after 14 days.

Finishing - Polishing of the tiles and the chequer grooves, after laying, may be done by hand as directed by Owner/PMC. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion except that the of the tiles.

The finished floor shall not sound hollow when tapped with a mallet.

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

Testing of the tiles shall be carried out by the Contractor at his own cost as per I.S. requirement.

## Kerb Stone (Precast)

1. **Laying**

Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion.

The kerb stones with top 20 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones with top 30 cm. wide shall be laid in position in chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement : 3 coarse sand) and pointed with mortar 1:2 (1 cement: 2 fine sand) which shall be cured for 7 days. The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Owner/PMC for connecting to storm water drains.

1. **Finishing**

Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed off as directed by the Owner/PMC. Nothing extra shall be paid for this.

## HDPE Grass Pavers

Providing and laying 40 mm thick **High-density polyethylene**  (HDPE) grass pavers on 150 mm thick sub grade of compacted bed of 20 mm thick nominal size stone aggregate and base course and filling with 150 mm thick sand, including spreading, well ramming, consolidating and finishing smooth etc. all complete as per direction of Owner/PMC.

The high strength plastic modules shall be designed to provide permeable surface on ground with at least 90% porosity and shall contain and stabilize grass or decorative gravel with the ability to withstand heavy loads imposed by emergency vehicles such as fire tender.

These modules shall be with Snap on connectors allowing each module to interlock with each other ensuring that they remain in place during & after installation.

The modules shall be planted with grass / ground cover enabling these areas to blend into the aesthetics of their surroundings.

The modules shall be made of 100% recycled materials and support LEED GOLD /Green Building Certification.

The minimum specifications shall be:

 Material : Polyethylene / Polypropylene

 Dimensions: : 500 mm x 500 mm

 Height: : 40 mm

 Cell Size (diagonal): : 70 mm

 Weight : ~4.3 kg/m2

 Compressive Strength (unfilled) : ~150 t/m2

 Compressive Strength (sand filled) : ~3000 t/m2

 Service Temperature : -30 °C to 80 °C

 Biological Resistance : Unaffected by moulds and algae

 Chemical Resistance : Resistant to rot, oils, acids, alkalis, bitumen and naturally occurring soil chemicals

## AAC Masonry Work

1. **Materials**

MASONRY to be used in the Building works shall be Autoclaved Aerated Concrete Blocks of size 600mm x 200mm x 200 mm with 55-60% Fly ash, 2-3% Gypsum, 10-12% cement, Lime 12-14%, Aluminum powder and balance slurry solids generated during process. Length and height can vary as per availability; however the thickness of blocks shall be 200mm and 100mm as per requirements.

Fly ash to be used in the manufacturer of fly ash cement masonry shall conform to Grade 1 or 2 of IS-3812-1981or latest version

Minimum percentage of fly ash to be used in the AAC masonry shall not be less than 40%. Manufacturers and test certificate and independent testing conforming chemical and physical requirement / characteristics and proportion of fly ash shall be produced by the contractor to the Owner/PMC for approval. Fly ash shall be procured from coal / lignite based thermal power plants.

Water absorption for the AAC masonry shall not be more than 20% of weight.

Efflorescence when tested according to IS-3495 (Part III) 1976 or latest version shall have the rating of efflorescence not more then 12.5%.

The Compressive strength of AAC blocks shall not be less than 4.0 N/sqm and shall conform to IS 2185 or latest version

The normal dry density shall be 550-650 kg/cum, sound absorption upto 42 dB, fire resistance of minimum 4 hours, thermal conductivity “K’0.16 W/sqmK, thermal resistance 0.46 K-sqm/W, heat transmission coefficient 2.17 w/sqmK and drying shrinkage not less than 0.02% (length of the block).

The AAC Blocks shall conform IS 2185 (Part III) or latest version and the masonry shall be carried out as per IS 6041 (1995) or latest version and IS 1905 (1987) or latest version.

1. **Workmanship**

 All masonry work shall be built in CM (1:6). / CM (1:4).

 Masonry work in panels shall be jointed with RCC columns by means of wall ties of MS flat 30mm x 3mm at every fourth course. The bonding length of reinforcement and MS flat shall be as under unless otherwise shown on drawings: -

1. Junction of 200 mm thick wall and RCC column etc.- 20cm

Faces of masonry walls indicated to be pointed on external faces of masonry work or where shown to be provided with pointing shall be faced with specially selected facing masonry. Masonry shall be uniform in colour, texture and shall have arises so that true horizontal and vertical joints are formed in the facing.

1. **Thickness of Masonry Wall/Pillar & Concrete Members**

Width of concrete lintels, beams, sills, columns and the like coming in conjunction with masonry walls/pillars shall be kept to the actual width of masonry work unless off sets have been specifically shown, in that case width as shown on drawings shall be maintained.

Centreline dimensions of rooms, verandahs etc as shown in drawings shall be maintained. Internal and overall dimensions if at variance from whatever is shown in drawings shall be deemed to have been amended accordingly. The dimensions of various heights shall be maintained as shown on the drawings

Mortar bed joints shall be such that four courses of masonry work and three joints taken consecutively shall measure 3 to 4cm in addition to the combined height of the masonry, themselves.

1. **Half Brick Work**

Masonry work in half brick walls shall be done in the same manner as described above that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced, 2 Nos. M.S. bars of 6 mm dia. shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4 (1cement: 4 coarse sand). Lime mortar shall not be used. Over laps in reinforcement if any shall not be less than 30 cm.

## Water Proofing

All water proofing work shall be carried out by specialists as approved by the Owner/PMC. Installation and materials shall be as per best practices for obtaining water proof work and as recommended by the manufacturer.

Water proofing work shall be commenced only after the surface is prepared, smooth rendered, cleaned free of dirt, dust and foreign matters, inspected and approved. Compressed air shall be used for effective cleaning of all surfaces. The vents and other projections through the roof shall be made absolutely secure before flashing.

All roof/ floor slabs shall be flat roof type RCC slabs. Necessary slopes shall be provided for drainage. The floor slabs shall be accordingly sunk to achieve the slopes/ drops shown on drawings and to accommodate different thickness of waterproofing / flooring/landscape requirements.

The entire water proofing has to be CFC free and low VOC or zero VOC

## Waterproofing For Toilets/ Kitchen / Balconies (Flat Slab)

1. The first part consisting of grouting the porous slab area (if required) with non-shrink cementitious grout.
2. The second part consisting of treating the cracks and construction joints by routing-out to a minimum ¾” x ¾” groove and treating it with a specialised non-shrink cementitious compound.
3. The third part consisting of making vata (gola) at the interface joint of the toilet slab and masonary wall with a specialised non-shrink cementitious compound.
4. The fourth part consisting of sealing / packing all joints of outlet pipes, etc. with a specialised non-shrink cementitious compound and topping it with High Performance Cementitious Waterproof Coating.

The fifth part consisting of providing and applying providing and applying Cementitious “Catalytic” In-depth Crystalline Waterproofing System of approved make, as per manufacturers’ specification to permanently fix non-soluble crystalline growth throughout the capillary tracts and pores of concrete at a speed of 30 cms per year inside concrete. The Cementitious “Catalytic” In-depth Crystalline Waterproofing System shall be able to withstand at least 405 ft. of water head pressure supported by at least two National Test reports showing clear Scanning Electron Microscopic (SEM) photographs of densified and mature crystals formation and Permeability test as per BS code conducted by CBRI. The concrete Should not absorb water more than 1.5 gms and not more than 1 mm from the concrete surface. The product to be listed in ICC-ES EVALUATION REPORT INDEX January 2009, 2010 & 2011 and the product should be green Certified under any Ecolabel program. The “Catalytic” In-depth Crystalline System shall be applied at a minimum coverage rate of 0.8 kg./sq.m. as per manufacturer’s specifications approved by Consultants over the entire toilet flat slab and on walls upto 1 M height from FFL in case of dry area and upto 2 M height from FFL in case of shower area. . The applied waterproofing coating should have a weight loss of less than 1m when tested for abrasion resistance, pull off adhesion of greater than 1n/mm2 as per and Static Crack Accommodation of 1mm according to ASTM-standards. Work shall executed by authorized applicator, complete as per the manufacturer specification and methodology.

Protective layer: providing and applying screed plastering with CM 1:4 mixed with Crystalline admixture over waterproofing system to a minimum thickness of 12mm as per manufacture’s specifications and site requirement.

1. **Waterproofing of Basement from Positive Side**

1. Raft / Grade Slab Water proofing – Membrane and Crystalline water proofing system

PCC concrete shall be laid below raft / footing etc., and levelled using a wooden trowel, and should be free of honeycombing, for the subsequent waterproofing treatment. This can be done by simultaneously spreading with a broom a 1–2 mm thick, 1:1 cement-sand slurry over ‘green’ PCC. The civil contractor shall cure the PCC by spraying water over it periodically.

The PCC shall be allowed to set for a minimum period of 24 – 48 hours and then clean the PCC concrete surface thoroughly. The surface should be free of loose material, dirt, dust, oil, grease or other foreign matter before start of waterproofing treatment.

All minor leakages on the PCC shall be plugged with Patch ‘n Plug mortar.

Two coats of “Catalytic” In-depth Crystallization Waterproofing System shall be applied by brush on the entire PCC below raft and the footings. The Waterproofing System shall include treatment of joints:

1. between the PCC and the Raft along the periphery,
2. between the columns and the PCC and
3. between the columns and the raft with Patch ‘ N Plug.

 “Catalytic” In-depth Crystallization Waterproofing System shall be allowed to set for at least 8 – 10 hours. The “applied” area shall be barricaded during the curing period of 24 Hours. The treatment achieves it full hardness in 24 hours and cannot be abraded by walking, moving trolleys, etc. Reinforcement tying work by civil contractor can commence after 2 days is completed.

Tying the reinforcement and casting the raft slab / footing to be done by the civil contractor. Just before the subsequent pour of raft concrete, Crystalline Material shall be applied to the entire thickness of the construction joint of the previous pour of raft concrete.

Prior to tying the reinforcement , for additional protection, approx.4mm thick membrane, consisting of a blended polyethylene/polypropylene membrane incorporating a cell mesh, enabling the membrane to mechanically bond with the poured concrete shall be laid. The membrane shall be supplied with one self-adhesive edge to provide sealed laps. At Membrane lap joints, vertical & horizontal joint or 90 offset, polyuria elastomeric shall used where ever it is required including Accessary. Work shall executed by authorized applicator, Complete as per the manufacturer specification and methodology.

1. Starter Joints Treatment -

Providing and fixing water swellable-basic polymer-hydrophilic water stops at all construction joints/ starter joints, water stop shall have unrestrained volumetric expansion up to 300% shore a hardness of 25 to 35, hydrostatic pressure resistance of 100 meters. Water stops shall be fixed to the concrete using approved adhesive and complete as per the manufacturers specification.

1. Retaining wall waterproofing – with available working space for retaining wall positive side waterproofing

After Casting the RCC Retaining Wall / footings , the same should be allowed to set for at least 24 – 48 hours.

After de-shuttering, the retaining wall / footing vertical surface should be cleaned thoroughly. The Contractor shall ensure that the surface is free of loose material, dirt, dust, oil, grease or other foreign matter, before starting the water proofing treatment.

Treatment of Construction Joints on retaining wall from outside:

1. Cutting ‘U’ shaped groove of approx. 10mm (W) x 10mm (D) along the construction joints with a chipping tools.
2. Filling / grouting the ‘U’ groove upto surface with Patch ‘n Plug mortar after application of Crystalline slurry in to the groove.

Treatment of Surface Honeycombs on the retaining wall from outside:

1. Removing unsound concrete upto sound concrete in a ‘U’ shaped cavity around the honeycombing.
2. Filling / grouting the ‘U’ cavity upto surface with Patch ‘n Plug mortar.

Treatment of Tie Holes on the retaining wall from outside :

1. Cutting ‘U’ Shaped cavity of approx. 2” (W) x 2“ (D) around the tie hole.
2. Filling / grouting the ‘U’ cavity upto surface with Modified Mortar / Patch ‘n Plug.

Providing and applying two coats of “Catalytic” In-depth Crystallization Waterproofing System shall be applied on the entire RCC retaining wall from outside / footing vertical surface. The treatment on the retaining wall shall extend from the toe of the raft upto minimum 1 m above the finished floor level.

 “Catalytic” In-depth Crystallization System shall be allowed to set for atleast 8 – 10 hours and then Contrcator shall start curing with water for 2 days at least 3 times a day.

.For additional protection. 4mm thick membrane, consisting of a blended polyethylene /polypropylene membrane incorporating a cell mesh, enabling the membrane to mechanically bond with the poured concrete shall be applied. The membrane shall be supplied with one self-adhesive edge to provide sealed laps. At Membrane lap joints, vertical & horizontal joint or 90 offset, polyuria elastomeric shall use where ever it is required including Accessary. Work shall be executed by authorized applicator, Complete as per the manufacturer specification and methodology.



 **“CATALYTIC” IN-DEPTH CRYSTALLINE WATERPROOFING SYSTEM WITH MEMBRANE IN BOX-TYPE FASHION**

 **GROUTING (FILLING) TREATMENT OF CONSTRUCTION JOINTS/ SURFACE HONEYCOMBS / TIE HOLES WITH ‘PATCH’N PLUG’ / MODIFIED MORTAR**

**PLUGGING TREATMENT OF LEAKING CONSTRUCTION JOINTS / LEAKING MISCELLANOUS POINTS (ONLY) WITH MODIFED MORTAR**

 **MAKING WATA AT JOINT BETWEEN PCC AND RCC RAFT WITH MODIFIED mortar**

1. **Waterproofing of U.G. Water Tank / U.G. Sump /STP underground water retaining structures**

Providing and laying waterproofing for UG water tank / UG sump as per specifications listed below:

1. Grouting the porous slab area with non-shrink cementitious grout (if required).
2. Treating the cracks and construction joints by routing-out to a minimum ¾” x ¾” groove and treating it with a Patch N Plug, a specialised non-shrink cementitious compound.
3. Making vata (gola) at the interface joint of the slab and wall with Patch N Plug, a specialised non-shrink cementitious compound.
4. Sealing all joints of outlet drain pipe, etc. with Patch N Plug, a specialised non-shrink cementitious compound.
5. Providing and applying two coats of “Catalytic” In-depth Crystalline Waterproofing System as per manufacturers’ specification to permanently fix non-soluble crystalline growth throughout the capillary tracts and pores of concrete. The “Catalytic” In-depth Crystalline Material shall be applied by brushing / spraying on the entire on the RCC slab from inside, on the RCC walls from outside (if accessible) , on the internal baffle walls (both sides) and on the RCC walls from inside, as shown in the diagram.



**GROUTING ANNULAR SPACE BETWEEN PIPE AND CORE-CUTS AND SEALING WITH XYPEX MODIFIED MORTAR**

**TREATMENT OF CRACKS / CONSTRUCTION JOINTS WITH XYPEX MODIFIED MORTAR, GROUTING THE POROUS AREA WITH N.S.C.G**

**VATA TREATMENT WITH XYPEX MODIFIED MORTAR**

**XYPEX “CATALYTIC” IN-DEPTH CRYSTALLINE WATERPROOFING SYSTEM**

Protective layer: providing and applying screed plastering with CM 1:4 mixed with Crystalline admixture over waterproofing system to a minimum thickness of 12mm as per manufacture’s specifications and site requirement. Work shall be executed by authorized applicator, Complete as per the manufacturer specification and methodology.

1. **Waterproofing for PODIUM – Extended Basement Roof Green Areas-**

Surface preparation: preparation of the concrete surfaces should be free from cavities and projecting nibs. All surfaces shall be dry and free from frost, surface laitance and contamination. System-

Concrete Waterproofing: The first part consisting of grouting the porous slab area with non-shrink cementitious grout.

The second part consisting of treating the cracks and construction joints by routing-out to a minimum ¾” x ¾” groove and treating it with Modified Mortar, a specialised non-shrink cementitious waterproof compound.

The third part consisting of making vata (gola) at the interface joint of the slab and building wall with Modified Mortar, a specialised non-shrink cementitious waterproof compound.

The fourth part consisting of sealing all joints of outlet drain pipe, etc. with Modified Mortar, a specialised non-shrink cementitious waterproof compound and topping it with liquid-applied Flexible Waterproofing Membrane.

The fifth part consisting of providing and applying Cementitious “Catalytic” In-depth Crystalline Waterproofing System as per manufacturers’ specification to permanently fix non-soluble crystalline growth throughout the capillary tracts and pores of concrete at a speed of 30 cms per year inside concrete. The Cementitious “Catalytic” In-depth Crystalline Waterproofing System shall be able to withstand at least 405 ft. of water head pressure. The Cementitious “Catalytic” In-depth Crystalline Material shall be applied by brushing at the coverage rate of 0.8 kg./sq.m on the entire landscape garden concrete slab and walls upto 300 mm above the top level of soil.

Additional protection shall be done by Providing and laying PVC waterproofing cum root repellent membrane of non-flammable type for waterproofing of basement slab, which shall be a 2.0mm thick loose laid membrane. Membrane layers are overlapped to achieve a weld of 50mm. Hot air welding can be either hand applied or by means of automatic machines and the rolls either ends are over lapped with 100mm are in staggered position. The membrane which shall be sandwich between separation layers of non-woven geotextile membrane. The separation layer provided to prevent the mechanical abrasion and cushioning between the waterproofing membrane and the concrete substructure.

Separation layer: on substrate fixing first separation layer of geotextile membrane min. 300 GSM, by overlapped 100mm followed by loose membrane hot welded system and fixing second separation layer of geotextile min 300 GSM & 140 GSM by over lapping 100mm the separation layers provided will prevent the mechanical abrasion between the membrane and the concrete substructure. Work shall executed by authorized applicator, Complete as per the manufacturer specification and methodology.

Horizontal surface- min 300 GSM+PVC Membrane+ min 300GSM.

Vertical surface-min 300GSM+PVC Membrane+ min 140GSM.

Providing and sprinkling of quartz pieces on the second coat of wet membrane to provide protection of membrane as well as bonding of subsequent screed. Brushing of the excess sand after the membrane is set.

**Protection, Insulation & Slope Making:**

1. Providing and laying average 15-20mm thick cement mortar 1:4 with required slopes.
2. Providing and laying 75mm thick (average) M20 grade concrete in proper slope with 12mm and down size aggregates and coarse sand admixed with Integral Waterproofing Compound.
3. PIPING NETWORK: Providing and fixing network of perforated pipes as per calculated design. The perforated pipe shall be half embedded in concrete and half popping-out of the protective plaster in the ninth part.
4. DRAINAGE: Providing and laying a drainage layer which is minimum 125 mm thick section of aggregate, coarse at the bottom and finer towards the top (this part shall be carried out by the gardening agency).
5. SOIL CONTAINMENT: Providing and laying polypropylene filtration geo-membrane.
6. Providing and laying earth / growing medium as specified by the horticulturist.

1. **Waterproofing For Terraces**

Surface preparation: preparation of the concrete surfaces should be free from cavities and projecting nibs. All surfaces shall be dry and free from frost, surface laitance and contamination.

System-

1. Preparation of the concrete surface by mechanical means to ensure a good bond between the coating and the substrate. Application of primer to seal the pores.
2. Insulation Layer with extruded polystyrene board - Providing and laying roof insulation with 75 mm thick Extruded Polystyrene boards over deck insulation (density of board being 32 kg/cum), over a coat of polyurethane primer, laying 120 gsm plastic film as a vapour barrier and 140gsm geotextile / polyester non-woven cloth on top of vapour barrier for differential expansion
3. Water proofing layer- Applying protective and water proofing coating , flexible two component, rapid curing, hybrid coating system, providing high corrosion resistance, abrasion and waterproofing resistance. The coating shall be spray applied in high pressure and in cross directional method to achieve minimum thickness of 1.5mm. The coating shall be taken upto a 300mm height and terminate on the parapet wall by providing groove. Cured waterproofing layer /seamless membrane shall exhibit the following Solids by volume : 100% tear resistance ASTM D624C:50 N/mm, Elongation ASTM D-412: >450% etc. Work shall executed by authorized applicator, Complete as per the manufacturer specification and methodology.
4. Separation layer - Providing non-woven polyester geotextile fabric of density 40 g/sq.m.
5. Protection layer (Horizontal) - Providing and laying minimum 75mm thick (thickness shall be as per terrace drainage design to provide required slope) screed concrete with incorporating Polypropylene fibre as per manufacturer’s dosage and admixed with water proofing compound (integral water proofing compound confirming to IS 2645), providing grove cutting at 4.0m c/c the joint size shall be 4mm x 15mm and shall be filled with PU sealant, all complete as per manufacturer’s specifications and instruction and as directed by Owner/PMC.
6. Heat-Resistant Tiles over protection layer - Providing and fixing Heat Resistant Terrace Tiles (300 mm x 300mm x 20 mm) with SRI (solar refractive index) > 78, solar reflection> 0.70 and initial emittance > 0.75 on waterproof and sloped surface of terrace, laid on cement sand mortar and grouting the joints with mix of white cement & marble powder in ratio of 1:1, including rubbing and polishing of the surface upto 3 cuts complete, including providing skirting upto 150 mm height along the parapet walls in the same manner.
7. Parapet wall- Providing and applying UVR wall guard at 110microns thick on the parapet wall for full height and including width of the wall, available in color, complete as per manufacturer’s specifications.
8. **General**

Bore packing- Prepare the inside surfaces by roughening using suitable file to get better adhesion prior to packing works. Cleaning the surface by wire brush followed by water jet to remove any laitance or loose flaky particles. Providing necessary formwork for packing the bore using suitable arrangement as per site conditions. Applying a coat of polymer coating to enhance adhesion between packing material and other surfaces and application of swellable gasket at the middle of over the pie external side and packing the gap using non-shrink cement polymer based grout upto the surface of the bore.

Treating cracks, construction joints- Chase opening the construction joint by providing “U” groove, removing the dust and cleaning the designated area. Filling the prepared surface using bonding agent as per manufacturer’s specifications, following by providing chemical injection treatment in form of pressure grouting to th cold joint by injecting cement slurry mixed with grout admixture in required consistency through pre fixed PVC nozzle, finishing, curing all complete as per manufacturer’s instructions and specifications.

Coving - Coving at junction of Horizontal and vertical surfaces with cement mortar 1:4 with SBR based liquid at required dosage as per manufacturer’s specification.

## Plastering Works

1. All plaster work shall be of the best workmanship and in strict accordance with the dimensions of the drawings. All plastering shall be finished to true levels including plumbs, without imperfections, and square with adjoining work. It shall form proper foundations for finishing materials such as paint etc. Masonry and concrete surface to which plaster is to be applied shall be clean, free from efflorescence, sufficiently rough and keyed to ensure proper bond.
2. Wherever directed all joints between RCC frames and masonry walls, shall be expressed by a groove in the plaster. This groove will exactly coincide with the joint beneath. At the corners of all windows and doors or other openings and wherever instructed, 24 gauge expanded galvanized metal mesh strips 300 mm wide shall be placed diagonally to prevent plaster cracks.
3. Where grooves are not called for, the joint between concrete and masonry in filling, chasing for conduits, pipes, boxes etc. shall be covered by 24 gauge expanded galvanized metal strips, 300 mm wide installed before plastering. The contractor shall supply all necessary labour, material, tools and scaffolding necessary for the completion of the work detailed. He shall be responsible to take proper precautions to all works from damage. Any work rejected through non-compliance with the specifications or damaged work shall be removed and replaced at the expense of the contractor.
4. All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Owner/PMC.
5. The materials used for plastering shall be proportioned by volume by means of gauge boxes. Alternatively it may be required to proportion the materials by weight.
6. The joints in the brick work, concrete blocks, shall be raked to a depth of 15 mm while the masonry is green. Concrete surfaces to receive plaster shall be suitably roughened. All walls shall be washed with water and kept damp for 10 hours before plastering.
7. The plaster unless specified otherwise shall be average of 15 mm thick on walls and minimum 6 mm thick for the ceiling. The finished texture shall be as approved by the Owner/PMC. The mix for plaster unless otherwise specified, shall be 1:4 (one part cement and four parts sand), to walls and 1:3 (one part cement, 3 parts sand) to ceiling.
8. The interior plaster shall be applied in one coat only. The surface shall be trowelled smooth to an approved surface. All plaster work shall be kept continuously wet for seven days.
9. The external plaster shall be minimum 18 mm applied in two coats -under layer 12 mm thick cement plaster 1:5 (1 cement : 5 coarse sand) finished with a top layer 6 mm thick cement plaster 1:6 (1 cement : 6 fine sand).. Preparations of walls to receive plaster work shall be the same as in internal plaster. Finishing plaster coat shall be, uniformly applied and surface finished with special rubbing by sponge pads and other tools and recommended by the Owner/PMC.
10. For rough cast plaster, the backing shall be floated with 3 mm thick cement mortar 1:4 with fine sand, spread in small areas not exceeding 2 Sq.mt. at a time. While this coat is still wet, the rough cast containing a mixture of 1 part of cement, 2 parts of fine sand and 1 part of gravel, 3 to 6 mm size, shall be dashed on the floating coat, to a uniform thickness of 15 mm thick and finished even.

## Italian Marble Flooring

1. The Italian marble should be factory processed, pre polished (mirror and diamond polished), surface calibrated, four side trimmed with the reinforcement of epoxy resin and fibre glass backing. The fixing of stone shall be done as per approved pattern and design with smooth and even surface without holes or pits. The top surface of full slab should be treated with epoxy resin (under vacuum & controlled temperature) with slab size not less than 1200 x 800 mm (or as approved) in combination of approved shades & colour, laid in 20 mm thick cement mortar 1:3 ( 1cement: 3 coarse sand) including finishing the joint with approved joint filler or approved make of approved shade etc to match the colour of Italian marble stone slab including edge polishing wherever required all complete as per directions & instructions of Owner/PMC.
2. The type, quality and thickness of granite slabs for flooring skirting and dado shall be of the best quality as described and approved by the Engineer and shall be hard, dense, uniform homogenous in texture, have even crystallizing gains and be free from cracks and other defects.
3. The Contractor shall provide the Owner/PMC with samples for approval and only approved slabs shall be brought on to the site.
4. Before laying sub- surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.
5. Slabs shall be laid in cement slurry over a cement mortar bed approximately 18mm thick (one part of cement four parts of sand) or as required at site evenly spread over sub-surfaces Slabs shall be gently tapped with a wooden mallet until properly bedded and level with adjoining slabs. Joints not exceeding 1 mm wide shall be perfectly straight and uniform in thickness. Slabs shall be laid perfectly level unless otherwise specified or directed by the Engineer. After laying, joints shall be finished with grout of approved make. Slabs laid adjoining walls shall project at least 12mm under plaster or under skirting or dados. After laying, flooring shall be allowed to cure undisturbed for 10 (ten) days and the surplus cement slurry shall be cleaned off.
6. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying slabs. Following curing, slabs shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such slabs, together with any cracked or broken slabs, shall be removed and replaced with new slabs to proper lines and levels. The above procedure shall be followed again after slabs are polished. To ensure that such replaced slabs match those laid earlier the Contractor shall order sufficient extra slabs to meet this requirement.
7. Pointing and Finishing **-**The joints shall be cleaned off the grey cement slurry with wire/coir brush or towel to a depth of 2mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with coloured epoxy grout as approved to match the colour of stone. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

After joints have developed sufficient strength floors shall be machine polished to diamond mirror polish finish to the satisfaction of the Owner/PMC. Sufficient quantities of water shall always be used during polishing to prevent scratching, For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with approximately a 12mim thick coat of cement mortar (1:2), Backs of cut slabs for skirting and dados shall be covered with a thin layer of neat cement paste and files gently tapped against the wall with a wooden mallet.

Joints shall be as close as possible and the work shall be truly vertical and flush. At the top of dado work borders shall be provided, if specified. Once work has set skirting and dado shall be hand polished with Carborundum stone to produce a high glossy finish. Corners and junctions shall be finished true. Dado shall be secured by means of stainless steel crawyers / fasteners as required.

1. All stones used on one face of the work shall be from the same lot and shall be of uniform colour, quality, texture and grain. The Contractor shall provide stones to match approved samples and they shall comply with the following:
	1. Stone shall be machine cut into slabs of required thickness and to the required sizes. Hard cutting shall be permitted only for curved pieces.
	2. Stone shall be properly seasoned and brought to the proper condition for use.
	3. Each worked stone shall be marked with the natural or quarry bed.
	4. Stone shall be supplied to the work site with all shape and match at the masonry yard.
	5. Feature stones shall be marked for identification with drawings
	6. Stone shall be finished, as specified, for all faces and returns etc., visible in the finished work.
	7. Stone shall be worked truly square from all face lines for the full width and thickness.
	8. The minimum thickness of stone behind a cramp mortise shall not be less than that specified.
	9. Tolerance in thickness: Up to 20mm thick +2mm and beyond 20mm +3mm
2. Handling and Storing Materials
3. The Contractor shall handle and store materials such that any particular delivery or consignment can be identified. Incompatible materials shall be stored separately.
4. All stone shall be stacked on a clean, dry, free-draining surface, be prevented from contact with soil and shall be protected from extreme weather conditions.
5. The stone shall be covered with non-staining tarpaulins and protected from rain.
6. The Contractor shall take steps to ensure that there is no danger of breaking and damage to the stone. The storage areas shall be clear of all other operations.
7. The Contractor shall prevent damage to the stone due to handling and transport.
8. Handling shall be planned and reduced to a minimum.
9. The storage, handling, lifting and transporting methods shall be subjected to the approval of the Engineer.
10. Protection -All stone work shall be covered with black polythene sheet and top of that with POP to avoid the damages, scratches till handing over or as per instruction of Owner/PMC.

## Granite Flooring

1. The granite stone should be factory processed, pre polished (mirror and diamond polished), surface calibrated, four side trimmed with the reinforcement of epoxy resin and fiber glass backing. The fixing of stone shall be done as per approved pattern and design with smooth and even surface without holes or pits. The top surface of full slab should be treated with epoxy resin (under vacuum & controlled temperature) with slab size not less than 1200 x 800 mm (or as approved) in combination of approved shades & colour, laid in 20 mm thick cement mortar 1:3 ( 1cement: 3 coarse sand) including finishing the joint joint filler of approved make of approved shade etc to match the colour of Granite stone including edge polishing wherever required all complete as per directions & instructions of Owner/PMC.
2. The type, quality and thickness of granite slabs for flooring skirting and dado shall be of the best quality as described and approved by the Engineer and shall be hard, dense, uniform homogenous in texture, have even crystallizing gains and be free from cracks and other defects.
3. The Contractor shall provide the Engineer with samples for approval and only approved slabs shall be brought on to the site.
4. Before laying sub-.surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.
5. Slabs shall be laid in cement slurry over a cement mortar bed approximately 18mm thick (one part of cement four parts of sand) or as required at site evenly spread over sub-surfaces Slabs shall be gently tapped with a wooden mallet until properly bedded and level with adjoining slabs. Joints not exceeding 1 mm wide shall be perfectly straight and uniform in thickness. Slabs shall be laid perfectly level unless otherwise specified or directed by the Engineer. After laying, joints shall be finished with grout of approved make. Slabs laid adjoining walls shall project at least 12mm under plaster or under skirting or dados. After laying, flooring shall be allowed to cure undisturbed for 10 (ten) days and the surplus cement slurry shall be cleaned off.
6. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying slabs. Following curing, slabs shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such slabs, together with any cracked or broken slabs, shall be removed and replaced with new slabs to proper lines and levels.
	1. The above procedure shall be followed again after slabs are polished. To ensure that such replaced slabs match those laid earlier the Contractor shall order sufficient extra slabs to meet this requirement.
7. Pointing and Finishing- The joints shall be cleaned off the grey cement slurry with wire/coir brush or towel to a depth of 2mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with coloured epoxy grout as approved to match the colour of stone. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.
8. After joints have developed sufficient strength floors shall be machine polished to the desired finish to the satisfaction of the Engineer. Sufficient quantities of water shall always be used during polishing to prevent scratching,
9. For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with approximately a 12mim thick coat of cement mortar (1:2), Backs of cut slabs for skirting and dados shall be covered with a thin layer of neat cement paste and files gently tapped against the wall with a wooden mallet. Joints shall be as close as possible and the work shall be truly vertical and flush. At the top of dado work borders shall be provided, if specified. Once work has set skirting and dado shall be hand polished with Carborundum stone to produce a high glossy finish. Corners and junctions shall be finished true. Dado shall be secured by means of stainless steel crawyers / fasteners as required.

## Kota Stone Flooring

1. Stones as described shall be of pre polished , approved quality, free of defects, hard, sound, durable and uniform thickness and approved by the Owner/PMC. Edges shall be chisel dressed and the top surface shall be machine polished with joints running true and parallel from side to side.
2. The Contractor shall provide the Owner/PMC with samples for approval and only approved stones shall be brought on to the Site.
3. Before laying stones, sub-surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.
4. Thoroughly wetted stones shall be laid on concrete mortar bedding not less than 12mrn and not more than 25mm thick in the proportions of one part of cement, two parts lime and six parts sand.
5. Mortar shall be evenly spread over sub-surfaces and covered with bed of cement at the rate of 5kg per square metre over areas that can be covered with stones within half an hour. Stones shall be laid on cement beds one after another, each stone being gently tapped with a wooden mallet until properly bedded and level with adjoining stones level unless otherwise specified or directed by the Owner/PMC. After laying, joints of stones shall be struck smooth. Floor stones laid adjoining walls shall project at least 12mm under plaster or render, skirting or dado. Cut pieces shall be avoided as far as possible. After laying flooring shall be covered with a layer of damp sand and allowed to cure undisturbed for 7 (seven) days.
6. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying stones. Following curing each and every stone shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such stones, together with any cracked or broken stones, shall be removed and replaced with new stones to proper lines and levels. To ensure that such replaced stones match those laid earlier laid the Contractor shall order sufficient extra tiles to meet this requirement.
7. For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with approximately a 12mm thick coat of cement mortar.
8. Backs of stones for skirting and dado shall be covered with a thin layer of neat cement paste and flies gently tapped against walls with a wooden mallet. Work shall be done from the bottom of the surface proceeding upwards. Joints shall be as close as possible and the work shall be truly vertical and flush.

## C.C. Flooring

52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate 6 mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer’s specifications. This includes cost of cement slurry, but excluding the cost of nosing of steps etc. complete.

## Vacuum Dewatered Flooring

Portland cement of 43 Grade conforming to IS:8112 of normal grinding fineness, which

corresponds to a specific surface of 2600-3500 cm2/g is required. Cement of higher grinding fineness, e.g. rapid-hardening Portland cement of larger specific surface shall be avoided especially in concrete mixes with cement content 0.3 t/m3 recommended content is 0.2 - 0.3 t/m3.

If stipulated in work specification; VDF Recron 3s synthetic fibres (manufactured by RIL or equivalent) may be used. Minimum dosage shall be 900 gms / m³ or as recommended by the manufacturer of the fibre.

The fibre shall be as per the following specification:

1. Cut length – 12mm
2. Shape of fibre – unique triangular cross section for improved bonding aggregates in

concrete.

1. Tensile strength – 4000 to 6000 kg/cm²
2. Melting point - > 250°C
3. Batching, Mixing, Transporting, placing, compaction finishing and curing shall be as per relevant clause.

If stipulated in work specification, floor hardener (Nitofloor hard top or equivalent) shall be laid as per manufacturer’s specifications with concrete as per intended use.

The Contractor shall be responsible for achieving the quality of concrete specified by controlling the concrete mixes, placing, vacuum process, finishing and curing. The concrete technician in charge must be present at the site when work is in progress.

The Contractor shall be required to maintain control charts showing individual test results for aggregate gradation, slump, air content, cement content and compressive strength. Data for slump, eventual air content and compressive strength shall be supplied to the MMCI/HPCL Engineer In-charge.

The Contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

Equipment

The following equipment shall be provided by the Contractor;

Poker vibrator with high frequency preferably 335 hz, dia 25 to 38 cm.

Double beam, surface vibrator. Beam should be adjusted to absolute straightness and controlled every morning before placing of concrete starts. Suction mat 100% made from air tight plastic material. Width of the mat shall be same as bay size and length 6m. Filter pad 1200 mm length, width shall be less than the bay width by about 200 mm. Vacuum Pump. Skim floater with disc.

**Execution**

**General**

The work shall be planned and executed so that there is no delay between the placement, screeding, dewatering and floating of the concrete. Concrete to be vacuum dewatered shall be handled and placed so as to prevent segregation. The concrete shall be internally vibrated prior to screeding.

**Levelling**

Immediately following placement, the concrete shall be levelled with a vibrating screed running on a true surface, set at the proper elevation required to provide the specified finished elevation. The concrete surface shall be screeded high by 2% of the slab's thickness to compensate for the compaction caused by the vacuum dewatering process. (Slabs that have an aggregate hardener shall have compensation made to maintain elevation). The vibrating screed shall be moved forward as rapidly as proper consolidation allows. The proper surcharge of concrete must be maintained in front of the leading edge of the screed.

**Vacuum Drying**

Immediately after levelling, the concrete shall be covered with filter pads and suction mats in strict accordance with the recommendation of the manufacturer to have the slab fully dewatered. The suction mat shall extend 10 cm beyond the edge of the filter pad on all sides.

The pads shall extend to within 10 cm of the edge of concrete slab and the mats shall cover the entire slab. Before connecting the hose on the suction mat to the vacuum pump, the edges of the mat shall be smoothed to enable an air tight seal to be created. A vacuum shall then be applied to the mat.

After a minute the gauge on the vacuum pump should indicate a minimum vacuum of 0.70 atmospheres (24.0 in Hg) and if not, the mat must be checked for leakage. For concrete that dewaters readily the vacuum should then be maintained at 0.70 - 0.80 atmospheres (24.0 to 25.5 in Hg). For concrete which dewaters less efficiently (e.g. air-entrained concrete) the vacuum shall then be reduced to 0.50 - 0.60 atmospheres (15.0 to 18.0 in Hg). After approximately 10 minutes the vacuum can then be increased to 0.80 atmospheres.

The vacuum shall be maintained for at least 3 minutes per 25 mm of concrete thickness at 0.80 atmospheres. (Where aggregate hardeners are specified, sufficient moisture shall be maintained to meet manufacturer's requirements). The suction mats and filter pads shall then be removed and moved to the next section in a leap frog manner.

The vacuum dewatering shall be stopped when only light foot prints are left in the concrete when stepped upon.

**Floating**

Upon removal of the suction mats and filter pads the concrete surface shall be power-floated without delay until all imprints from the vacuum process are removed.

**Finishing**

The waiting time after the floating operation depends on concrete temperature and humidity and varies from 10 minutes to 2 hours.

The trowelling operation cannot take place before the concrete has hardened enough to carry the machine i.e. the trowelling blades shall not leave any marks on the concrete. Repeated trowelling, with intervals between the passes, which are adapted to the setting of the concrete, greatly improves the surface characteristics. At least two passes shall made for floors which are not to be covered.

**Curing**

Vacuum dewatered concrete shall be cured like any other quality concrete in order to achieve a good final result. Curing compounds or plastic sheets shall be used.

**Acceptance Criteria**

In general, the following shall be checked for acceptance:

Concrete cube strength as specified in the drawing

General level of finish of the floor shall not vary by + 5 mm in 10 metres Finished floor shall not exhibit cracks, creases and crustiness. It shall be sound at edges and corners.

Floor shall not have laitance and shall not generate dust on movement of traffic. It should not give hollow sound on tapping.

During Inspection if any of the above defects are observed, Contractor shall be informed of non-acceptance and the Contractor shall in workman like manner take all necessary corrective action without undue delay at his cost so that the installation meets all acceptance criteria.

## Stone Cladding Works

1. **Granite / Italian marble Cladding**

The Contractor shall be responsible for the design, supply of clamps for fixing, fabrication and installation of all items specified in the drawings and bill of quantities.

Scope of work- The work as described include providing of clamps for fixing, designing and installing of interior stone wall cladding as shown in the drawings, and specifications.

Granite cladding hereinafter shall be deemed to include internal granite dry wall claddings, wet granite fixing, sealing of joints and gaps between granite panels.

Preparation of dimensioned shop drawings including full detailed designs, including fixing etc.

1. Co-ordination with Contractors of other trades
2. Preparation of sample mock-ups and necessary testing
3. Cutting of stones at site as may be required for fitment and polishing of side edges as may be required
4. Matching of stones for shades, grains etc. before installation
5. Silicone sealant between two joints

Contractor shall submit shop drawings which should also show the panel sizes, type and brand of clamps etc. and co-ordination with works of all other trades as may be required, prior to fabrication.

Contractor shall fabricate, cut, finish and install each type of stone in accordance with approved shop drawings. Contractor shall furnish and install stone supporting system, anchors, plates, bolts, inserts, washers and all other fastening or hanging devices or accessories necessary for complete installation of stone work.

Contractor shall provide mortar bedding to stone work wherever required, perform cleaning of all stone after installation and prior to acceptance, protect stone work as required, perform all testing as required and apply silicone sealant as required.

All cladding material shall be subject to Owner/PMC in charge review as well as testing in any laboratory specified by the Employer. Any granite panels rejected/ changed form confirmed shop drawings shall be removed from the site and replaced with material meeting the Owner/PMC in charge requirement at no additional cost or time.

The Contractor shall ensure that the stone edges at all such joints are in true line and level.

1. **Edge treatment**

Each panel of granite shall be accurately cut square, polished around its edges and holes drilled on edges to take up the anchor pins to the satisfaction of the Consultant / Employer /Owner/PMC. The holes, notches or grooves shall be pre-dressed with silicon sealant as per approval. All this preparation of the granite slabs must happen before they are fixed in position and the accuracy of right angles, dimensional stability and sizes of holes shall have to be tested on site using a mould and other measuring instruments as decided by the Owner/PMC or edges to be 23 mm beveled and polished.

1. **Stone support and anchorage**

All elements of the support system should never rust or corrode under exposed condition. All metal components like anchors, bolts etc shall be in stainless steel of AISI 304, which shall be tested frequently by the Owner.

1. **Cutting, drilling and fitting**

Scope includes all cutting, drilling and fitting of stone work required to accommodate the work of other trades in cutting and fitting, carefully cut and grinding edges to a neat, tight fit, cutting in such a manner so as not to impair strength, appearance or architectural design of stone work use physical templates and accurate site measurements for all cutting and drilling. Contractor shall obtain required templates from proper trades.

1. **Workmanship**

Surface to receive granite cladding shall be examined in detail and site measurement shall be taken. Responsibility for the following shall be on the Contractor.

1. Line and Level
2. Verticality
3. Structural Support
4. Provisions for Expansion and Contraction
5. Water Tightness
6. Finished Appearance

The Contractor shall verify all measurements and dimensions, co-ordinate and supervise the installation of inserts for this work, Co-ordinate and schedule this work with the work of other trades giving particular attention to the location and size of cut-outs required to accommodate mechanical, electrical, and other works or adjoining constructions in accordance with the reviewed shop drawings for such trade.

1. **Preparation for Stone Cladding Work**

During the preparation for the stone cladding work the Contractor shall consider the building as a whole while planning, detailing etc. and not treat any face or part thereof in isolation.

1. **Matching Grains and Colour**

All stone shall be sorted for colour and grains before laying. The matching of grains/colour shall be carried out as approved by the Owner/PMC. No variation of type of grain or colour shall be allowed in any one area.

1. **Design and Pattern**

All work shall be laid as per design, detail, pattern, colours, sizes and dimensions given on the drawings. Any modifications and variations at site shall be reflected in adjustment in design as per the approval of the Owner/PMC. All junctions, rebates, nosing’s, corners shall have square, curved or shaped mounting as desired and as shown on the drawings

1. **Service and Other Outlets**

Before any work is to be taken up, the sizes and the pattern of stones shall be laid out, together with the location of electrical, sanitary outlets and those of all other services and approval sought from the Owner/PMC. Thereafter the stones shall be laid out on the floor showing pattern of grain, etc. and work shall only be carried out after obtaining approval of the Owner/PMC.

1. **Setting out**

The Contractor shall set out the stone cladding work so as to achieve the following:

1. Establish a benchmark or datum at each floor level for setting out.
2. Establish a vertical centre line in each plain area.
3. Establish the positions of movement joints.
4. Avoid or minimize unsightly cutting.
5. Obtain truly horizontal joint lines.
6. Where openings and other features occur the work shall be done as per the detailed
7. drawings or as directed by the Owner/PMC.
8. Preliminary

The Contractor shall undertake everything necessary to obtain a satisfactory bond between the backgrounds, backings and finishing / cladding. Such work shall include but not be limited to the following:

Withholding application until curing and drying shrinkage of the structural backgrounds are achieved.

1. Fungicidal wash as approved to remove any organic growth.
2. Removal of any greasy deposits by scrubbing with water and approved detergent.
3. Final brushing to remove laitance, efflorescence or loose material.
4. Wetting to reduce suction or to obtain uniformity of suction.
5. On hard smooth surfaces (such as high grade concrete) or other surfaces presenting an inadequate key, an adhesive of approved make and brand shall be applied. The adhesive shall be applied by spraying a thin coat of rendering done while the adhesive is still tacky. The provision of the bonding coat shall be deemed to be included in the rate for stonework.
6. **Laying**

The stone cladding shall be conducted as follows:

1. All stones and all jointing surfaces shall be made perfectly clean and free of dirt, dust, grease or other deleterious material.
2. The stones shall be soaked in clean water for at least 30 minutes.
3. The rendering shall be damped just sufficiently to prevent excessive water absorption from stones.
4. The bedding surfaces of small units shall be well wetted and the units stood on a full bed of mortar and tapped home.
5. For every large or heavy unit, a mortar bed shall be screed level and full but kept back 20mm from the face, before the stone is lowered into place. All joints shall be as completely filled as possible.
6. Only sufficient mortar shall be spread to bed each stone.
7. It shall be ensured that there are no hard lumps in the mortar that could prevent even bedding.
8. Spacer dabs: Spacer dabs of appropriate mortar, or, for linings only, Plaster of Paris, can be used to achieve resistance against inward movement of the stones and shall be of such consistency and size that they will be in permanent contact with the back of the stone cladding and the structure. It is essential that they do not bridge movement joints.
9. It shall be ensured that stones are flat and true by means of a straightedge. Adjustments if necessary shall be made within 10 minutes of fixing.
10. **Jointing**

The stone shall be fixed with consistent joint width by correct use of spacer lugs so as to provide hairline (maximum 1 mm thick) joints. All joints shall be filled solid with 1:2 mortar (1 white cement with pigment: 2 sand) except for projecting members of overhanging cornices, which may be provided with hollow bedding where approved by the Owner/PMC. Excess mortar shall be cleaned off immediately so that no mortar is visible on the face of the stone cladding. The stone cladding shall be properly cured for at least 7 days.

All stones shall be secured to the backing by means of stainless steel cramps, pins, anchors, fasteners and expansion bolts as shown on the approved shop drawings and as directed by the Owner/PMC.

All cramps, dowels etc. shall be fitted and grouted solid as the work proceeds. The fixings shall be secured to concrete backings using expansion fasteners and bolts. No stone shall bridge the expansion / separation gap provided in the structure.

1. **Grouting**

The stone joints shall be grouted as follows using epoxy grout of approved make in matching colour of stone in the proportion as recommended by the manufacturer / as instructed by the Owner/PMC.

1. Grouting shall be done at any time after the stones are firmly fixed but before any dirt or contamination can enter the joints.
2. Grouting materials shall be mixed to correct consistency and applied to as large an area as can be worked before hardening commences.
3. The grout shall be worked well into the joints / gaps between the stone and the backing until they are completely filled.
4. When the grout has set, the surplus material shall be removed and the joints tooled to required profile. When the grout has hardened the stones shall be washed down with water and finally rubbed with a gunny cloth. If any hollow grounding is detected by tapping the stones, these shall be taken out and re-laid.
5. **Polishing**

The stone cladding shall be polished to the desired finish.

1. **Attachments/Fixings**

The Contractor shall ensure that the number of fixings is in accordance with the specifications, drawings and directions of the Owner/PMC, and that the fixings are properly made. Over tightening and bending of fixings to accommodate inaccuracies shall not be allowed.

Each vertical unit shall be secured with two supports cum restraint purpose fixings and two restraint purpose fixings plus two pins. Each soffit unit shall be secured with four supports cum restraint fixings or as approved.

The accidental size of a cramp shall not be less than 25mm x 6mm and the pins used for securing adjacent stones shall not be less than 75mm long and 6mm diameter or as approved.

The minimum thickness of stone behind a cramp mortise shall be 18mm and the minimum depth of slot for a corbel plate shall also be 18mm or as approved.

The minimum depth of the expansion bolt to be considered for effective penetration shall be as given in Table below:

|  |  |
| --- | --- |
| **Type of Fixing** | **Structural Backing Material** |
| **Concrete** | **Brickwork** |
| Load Bearing | 75mm | 100mm |
| Sofia | 75mm | 100mm |
| Restraint | 75mm | 100mm |

1. **Movement Joints**

A clear 10mm wide horizontal joint may be provided at every floor level as approved the shop drawings. The joints shall be formed using a shelf type stainless steel channel shaped or Z-shaped load bearing fixing. An approved sealant shall be provided in the movement joints. The joint for sealants shall be clean, dry rectangular and formed by means of a removable fillet (such as pre-molded joint filler) for the depth of the stone cladding and backing. The joint shall be later duly sealed after cleaning, drying and placing backing material. The treatment for the horizontal and vertical separation/expansion joints shall be done in a similar manner.

1. **Ancillary Work**

**General**

The Contractor shall:

1. Form shall chases and fixings, etc. as the work proceeds.
2. Temporary support or brace items liable to distortion.
3. Cut into masonry subject to the followings:
	* Delay cutting until the mortar has hardened.
	* Perform cuttings in a manner that involves minimal vibration to the wall.
4. **Circular Columns, Circular Walls**

Stone facing to circular column/walls shall be provided to match the profile of the columns/walls as specified. The height of the stone shall match that of the course shown in the drawings.

1. **Scaffolding**

All scaffolding as required shall be provided till the completion of work.

1. **Tolerance for Finished Work**

The finished work shall conform to the following tolerance.

1. All the hairline joints shall be in perfect lines and levels.
2. Plumb.

i. In any 3m ± 5mm

ii. Maximum per floor ± 10mm

iii. Maximum for total height ± 15mm

1. Horizontal :

i. In any 3m ± 5mm

ii. Maximum for total length ± 10mm

1. **Cleaning, Completion and Mock-up**

On completion of the first area of stone cladding, once it is duly cured and dried the Owner/PMC shall examine the same to ascertain whether the quality of workmanship and finish is as desired. If the quality is accepted by the Owner/PMC as the desired finish the same area shall be cleaned of all dust and other deposits by washing together with detergent or other admixtures, with the approval of the Owner/PMC.

Upon completely drying, it shall be finished with an application of silicone water repellent solution to seal the surface. This area of stone work shall be retained as a sample of finished stonework, wherein the effects of weather, movement and other conditions shall be reviewed over a period not exceeding one month and the effects if found leading to unsatisfactory work, shall be remedied by the Contractor, until a satisfactory sample of finished work is accepted.

All subsequent work shall thereafter be completed to the standard and quality as approved for the above mock-up. In case any portion is not done to the desired quality the same shall be deemed to be rejected and shall be removed and replaced at no extra cost.

1. **Protection**

The Contractor shall:

Create adequate facilities to protect work adjacent to stone surfaces from damage.

Protect exposed flat and corner surfaces of stone work from damage or defacement Prevent materials used for installing work of this section from staining the exposed surfaces of stone work or the exposed surfaces of the adjoining construction. Immediately remove sealant, mortar grout or other detrimental materials from exposed surfaces of stone cladding or adjoining construction.

After installation, protect stone work from damage during subsequent construction activities. Provide whatever means, methods, and/or materials required protecting all in-place stone work from any damage whatsoever resulting from the work of other trades. Be responsible to remove and replace any damaged or defaced stone work. Remove protection when no longer required.

1. **Completion cleaning and commissioning**

Before declaring the installation “Completed and Commissioned”, the Contractor shall clean exposed surfaces of all stone work with clean water and stiff fiber brushes until all dirt, stains, efflorescence, and mortar other defacements are removed using cleaners and procedures recommended by the stone quarry and fabricator. Use of wire brushes, metal scrapers or acids shall not be permitted. Protection of adjacent surfaces from damage during cleaning operations shall be the responsibility of the Contractor.

Before handing over, all the stone surfaces shall be thoroughly checked and inspected to ensure that no spots or external marks remain. Wherever such spots or marks are detected, they should be brought back to their true natural colour, shade, grains, polish, luster etc.

## Vitrified and Ceramic Tile Work

1. Tile shall be of approved make and they shall be flat and true to shape and free from blisters, crazing, chips, welts, crawling or other imperfections detracting from their appearance. Tile shall be ISO 9002 approved.
2. The tiles shall be square or rectangular of nominal size such as 300 x 300 mm, 600 x 600mm, 800mm x 800mm as directed by the Owner/PMC. The thickness of the tiles shall be 10 mm as specified. The length of all four sides shall be measured correct to 0.1 mm and average length breadth shall not vary more than + 0.1% mm from specified dimension. The variation of individual dimension from average value of length/breadth shall not exceed + 0.5 mm. Tolerance in thickness shall be + 1%.
3. The top surface of the tiles shall be unpolished /polished/rustic/matt finished as per drawing. Technical data for Vitrified tile

| **Technical** | **Norm** | **Standards** |
| --- | --- | --- |
| Chemical Resistance | EN 106 | No Damage |
| Colour Resistance to Light | DIN 51094 | No noticeable colour change must take place. |
| Breaking Strength | ASTM C-648 | > 1113 N |
| Resistance to Thermal Shock | EN 104 | No Damage |
| Skid Resistance (Industrial Application) | DIN 51130ZH 1/571 | > R9 |
| Skid Resistance(Bare-footed traffic) | DIN 51097 |  |
| Determination of Dimension | EN 98 | - |
| Sides | EN 98 | + 0.5% |
| Thickness | EN 98 | + 5% |
| Straightness of sides | EN 98 | + 0.5% |
| Rectangularity | EN 98 | + 0.6% |
| Surface Flatness | EN 98 | + 0.5% |
| Water Absorption | EN 99 | <0.5% |
| Flexlon Resistance | EN 100 | > 27 N/mm2 |
| Abrasion Resistance | EN 102 | < 204 mm3 |
| Frost Resistance | EN 202 | > 6 MOHS |
| Coefficient of Linear ThermalExtension | EN 101 | @ < 9 x 10 C1 |

1. The type, quality, size thickness and colour of tiles for flooring, skirting and dados shall be of the best quality as described and approved by the Owner/PMC.
2. The Contractor shall provide the Owner/PMC with samples for approval and only approved tiles, skirting and dados shall be brought on to the Site.
3. Before laying tiles, sub-surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.
4. Tiles shall be laid on cement concrete mortar bedding 12mm thick in the proportions of one part of cement, and four parts sand. Tiles shall be laid on mortar beds one after another. Each tile being gently tapped with a wooden mallet until properly bedded and level with adjoining tiles. Joints shall be perfectly straight and uniform in thickness. Tiles shall be laid perfectly level unless otherwise specified of directed by the Owner/PMC. After laying joints of tiles shall be finished with epoxy based grout of matching shade and colour as described.
5. Floor tiles laid adjoining walls shall project at least, 12mm under plaster or render, skirting or dados. Half tiles and cut pieces shall be avoided as far as possible.
6. After laying, flooring shall be allowed to cure undisturbed for 7 (seven) days.
7. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying tiles.
8. Following curing each and every tile shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such tiles, together with any cracked or broken tiles, shall be removed and replaced with new tiles to proper lines and levels.
9. For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with a 12mm thick coat of cement mortar (1:2). Backs of tiles for skirting and dados shall be covered with a thin layer of neat cement paste and tiles gently tapped against the wall with a wooden mallet.
10. Work shall be done from the bottom of the surface proceeding upwards. Joints shall be as close as possible and the work shall be truly vertical and flush corners and junctions shall be finished true.
11. At the tops of dado work glazed tile borders, if specified, shall be provided.
12. Floor tiling and dados shall be measured in square metres after making deductions for openings and the like. Skirting shall be measured in linear metres for specified widths or as per Bill of Quantities. Quoted rates quoted for flooring, skirting and dado work shall be inclusive of forming angles, corner pieces and approved borders.

## Ceramic Tile in Dado/ Skirting

1. TILES- The tiles shall be of approved make/manufacturer. They shall be flat, and true to shape and free from cracks, crazing, spots, chipped edge and corners. The surface shall be of uniform shade except for patterned tile.
2. The tiles shall be of nominal sizes of 300 x 600 mm or as approved. The thickness of the tiles shall be 8-10MM unless otherwise mentioned.

|  |  |
| --- | --- |
| **Technical** | **Standards** |
| Determination of Dimension | - |
| Sides | ± 0.5% |
| Thickness  | ± 0.5% |
| Straightness of sides | ± 0.5% |
| Rectangularity | ± 0.6% |
| Surface Flatness | ± 0.5% |
| Surface Quality | 95% free from visible defects |
| Water Absorption | > 10% and less than 20% |
| Flexion Resistance | > 10% |
| MOHS Hardness | Min. 3 |

1. Color and pattern - The tiles shall be as approved.
2. Preparation of surfaces - The joints shall be racked out to a depth of at least 12 mm in masonry walls, while the masonry is being laid. In case of concrete walls, the surfaces shall be backed and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting/dado is commenced.
3. Mortar - 12mm thick plaster of cement, mortar 1:3 (1 cement : 3 coarse sand) shall be applied and allowed slightly to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at close intervals.
4. Laying of tiles - The tiles shall be soaked in water, adequately washed clean, and a coat of neat cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and butt jointed. The joints shall be as fine as possible and uniform. Top of dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Where full size tiles cannot be fixed these shall be cut to the required size and their edges rubbed smooth. Care shall be taken to ensure that as far as possible cut tile are in non-exposed locations. Works shall be carried out in all areas only after the Consultant has approved a sample panel.
5. Pointing -After laying is complete, the joints shall be cleaned off the grey cement grout with wire brush and all dust and loose mortar removed. The joints shall then be flush pointed with white cement slurry added with approved pigments to match the colour of tiles.
6. Curing and finishing -The surface shall be cleaned and kept wet by sprinkling water for seven days. The finished surface shall be clean, free of patches and glossy and shall not sound hollow. Finished dry surfaces shall be washed with mild organic acid, if so required. The finished surface shall meet the approval of the Consultant.

## Wooden Prelaminated Flooring

1. **Standards**

| **Description** | **Minimum Requirement** |
| --- | --- |
| Usage | Method of test shall be as per EN 13329 |
| Wear resistance | As per EN 13329 |
| Impact Resistance | As per EN 13329 |
| Stain resistance | As per EN 13329 |
| Cigarette burns | As per EN 13329 |
| Colour fastness | As per EN 13329 |
| Slip resistance | Shall not be less than 0.60 (As per ASTM C 1028) |
| End joint displacement | A minimum of 200mm between joints shall be maintained |
| Indentation resistance | Shall not be less than 600 kg / sqcm. (As per DIN 52185) |
| Electrostatic charge | 0.9 kV (As per DIN 54345) |
| Formaldehyde emission | As per EN 717 – 2 |
| Fire resistance | B1 (As per DIN 4102) |

1. Material
2. Laying of Floor

 The laminate flooring shall be of first quality and shall adhere to all the relevant international standards. It shall be of approved shade, make, design and quality and shall be laid in a pattern / layout as per the specific requirements of the architect. The flooring planks shall be hard, durable and shall require minimal maintenance.

1. Workmanship
2. Laying of Floor

The floor shall be installed at room temperature strictly as the guidelines prescribed by the manufacturer. The floor may be installed as a floating floor at the discretion of the Owner/PMC. The sub floor shall be dry, rigid, even and clean. Care shall be taken to ensure that the floor is not laid in wet rooms or in rooms provided with floor drains.

A polyethylene film of minimum 0.2 mm thickness shall be provided as a moisture barrier over the sub floor prior to laying the laminate flooring. The contractor shall ensure to provide a gap of about 12 to 15mm from all the walls and fixed objects to allow for the flooring to settle in the environment. The plank profiles shall be fixed securely into the sub floor.

An approved flexible sealant made out of acrylic or polyurethane shall be used for fixing the flooring. The entire expansion space shall not be filled. The planks shall be installed lengthwise, parallel to the side walls in small corridors and passages. The planks shall be fixed preferably in a direction towards incoming light. The top layer shall be of polyurethane type finish in order to maintain the aesthetics of the flooring.

1. Protection and Maintenance

Whenever glue is used for fixing, the excess glue during fixing shall be removed immediately with a scraper and damp cloth. A constant indoor room climate of 40 to 60% RH, shall be ensured at the time of installation. No furniture or any other heavy object should be dragged on the floor after installation. The flooring shall be cleaned with an upright vacuum cleaner or a damp cloth and a dry broom. Steam cleaners shall not be used. The floor shall not be sanded, waxed, lacquered or treated with film forming agents or abrasive materials.

1. Testing

The testing for various properties shall conform to the various international standards as listed in standards above. The flooring after installation may be tested for straightness and evenness using a straight edge. If any undulations are noticed, the same may be rectified complete to satisfaction of the Owner/PMC

## Cementitious Self Levelling Compound Base (Considered For Under Wooden Flooring, Carpet and Vinyl Flooring Only) - Average 3-5mm thick Cementitious Self-Levelling compound to be applied with primer complete as per manufacturer's guidelines. The existing floor shall be cleaned for loose particles; latent concrete, cement mortar/concrete lumps, dust etc., & making the existing floor ready for receiving the screed by repairing pot holes/ cracks/ joints etc with repair mortar. Vendor shall inspect the site condition & confirm that the existing floor is ready for receiving the proposed Self levelling Compound screed.

To conform to the following standards:

* Compressive strength

 After 1 day 19N/mSqm

 After 3 days 26 N/mSqm

 After 28 days 47 N/mSqm

* Indentation resistance

 After 1 day 80N/mSqm

 After 3 days 90 N/mSqm

 After 28 days 125 N/mSqm

## Painting Works

(All Paint Shall Be Low VOC Paint as per LEED GOLD guidelines)

1. Scope Of Work - This Specification describes the general requirements of painting and decorating on internal and external surfaces, woodwork and metal work and varnishing and polishing to be executed on projects.
2. Painting, Lime Washing And Colour Washing
3. General

 Paint, lime wash and colour wash shall except for white wash, be factory made, delivered to Site in manufacturers' sealed drums in colours approved by the Owner/PMC and conform to the relevant Standards.

 Paints shall be such as to be capable of withstanding the effects of weather and the atmosphere and the results of wood decay and metal corrosion and shall have good spreading coverage, be easy to apply, form a thin uniform film upon application, not crack when dry and have hard and durable surfaces.

1. Lime Wash

 Materials for lime wash shall be freshly burnt fat lime of good quality free from unburnt stone and other foreign matter dissolved in sufficient quantities of water (4 to 5 litres per kg. of lime), stirred thoroughly and strained through a clean coarse cloth. Clean gum or Fevicol dissolved in hot water shall then be, added in the proportion of 20 gm of gum per litre of lime to prevent lime wash being removed when rubbed.

 Surfaces shall be prepared by removing all mortar droppings and other deleterious foreign matter and thoroughly cleaned with wire or fibre brushes to the approval of the Owner/PMC. Holes and/or depressions shall be stopped with mortar and cured prior to lime washing.

 Lime wash shall be applied by brush, the first stroke being from the top downwards, the second from the bottom upwards over the first stroke and similarly with strokes from right and left over the first strokes before they dry. This application forms one coat and each coat shall be allowed to dry and shall be subject to inspection by the Owner/PMC before the next coat is applied. When dry surfaces shall not show signs of cracking and present a smooth and uniform finish free from brush marks, not easily removed when rubbed. Patchy or streaky work will be rejected and shall be re-executed at the Contractor's own expense.

 Doors, windows, floors, fittings, fixtures and the like shall be protected from splashes, splashing and droppings, if any being removed and surfaces thoroughly cleaned to the satisfaction of the Owner/PMC.

1. Colour Wash

 Colour wash shall consist of lime wash composed as described above to which a solution of water and lime fast pigment, boiled if directed, shall be gradually added and stirred until the required tinge is obtained to the satisfaction of the Owner/PMC.

 Surfaces shall be prepared by removing all mortar droppings and other deleterious foreign matter and thoroughly cleaned with wire or fibre brushes to the approval of the Owner/PMC. Holes and/or depressions shall be stopped with mortar and cured prior to colour washing.

 Colour wash shall be applied by brush, the first stroke being from the top downwards, the second from the bottom upwards over the first stroke and similarly with strokes from right and left over the first strokes before the dry. This application forms one coat and each coat shall be allowed to dry and shall be subject to inspection by the Owner/PMC before the next coat is applied. When dry surfaces shall not show signs of cracking and present a smooth and uniform finish free from brush marks not easily removed when rubbed. Patchy or streaky work will be rejected and shall be re-executed at the contractor's own expense.

 Doors, windows, floors, fillings, fixtures and the like shall be protected from splashes, splashing and droppings, if any, being removed and surfaces thoroughly cleaned to the satisfaction of the Owner/PMC.

1. Oil Bound Distemper

 Washable oil bound distemper shall conform to IS codes and be of approved make and shade and shall be applied only in dry weather with a broad stiff brush in long parallel strokes.

Priming coats shall be applied to completely dry surfaces as recommended by the manufacturers of patent distempers and approved by the Owner/PMC and allowed to dry thoroughly before the next coat is applied.

Surfaces shall be cleaned and all cracks, holes and surface defects repaired with gypsum and allowed to set hard. All irregularities shall be removed by sand papering smooth and wiped clean and surfaces so prepared shall be completely dry and free from dust before distempering is commenced. In the case of ·newly plastered surfaces special care shall be taken to ensure that they are completely dry before any application is attempted.

Existing, previously distempered surfaces shall be cleaned of grease, dirt, dust and other deleterious matter and cracks, holes and surface defects repaired with plaster of Paris, allowed to set hard, sand papered smooth and wiped clean. Flaking from previous coatings, if any shall be thoroughly removed.

1. Acrylic Emulsion Paint

 Acrylic emulsion paint shall be of approved make, colour and shade to the satisfaction of the Owner/PMC.

Acrylic emulsion paint shall be diluted by the addition of a quantity of water equivalent to half the volume of the paint to be applied. The paint and water shall be thoroughly mixed and then strained through cloth.

Priming coats shall be applied to surfaces by brush and allowed to dry properly; holes and depressions being filled with putty prepared with whitening and plastic emulsion paint and rubbed smooth and dry and touched up with plastic emulsion paint.

Subsequent coats, diluted by the addition of a quantity of water equivalent to about 15% to 20% of the volume of paint to be applied shall be applied to surfaces by brush and allowed to dry thoroughly so that no brush marks shall be seen.

Surfaces shall be cleaned and all cracks, holes and surface defects repaired with gypsum and allowed to set hard. All irregularities shall be removed by sand papering smooth and wiped clean and surfaces so prepared shall be completely dry and free from dust before painting is commenced. In the case of newly plastered surfaces special care shall be taken to ensure that they are completely dry before any application is attempted.

Existing, previously distempered or painted surfaces shall be cleaned of grease, dirt, dust and other deleterious matter and cracks, holes and surface defects repaired with plaster of Paris allowed to set hard, sand papered smooth and wiped clean. Flaking from previous coatings, if any shall be thoroughly removed.

1. Oil Painting

General

 Oil paint shall conform to the relevant Standards and be of the specified make, colour and shade as approved by the Owner/PMC. Materials shall be obtained directly from approved manufacturers and brought to Site in manufacturers' sealed drums and tins for inspection by the Owner/PMC.

 Paint for undercoats and finishing coats shall be ready mixed. Mixing by the Contractor shall not be allowed except with the prior written permission of the Owner/PMC, in which case preparation of the ingredients and the control of quality shall be in strict conformity with the manufacturers' recommendations and the relevant Standards and Codes of Practice.

 Materials shall be properly stored and protected when not in use with the lids of containers kept tightly closed. Paint in open containers during painting operations shall be covered with a thin layer of turpentine to prevent the formation of skin on the surface.

 If required by the Owner/PMC paint supplied by the Contractor shall be quality tested in an approved laboratory as described in IS codes. Rejected paint shall be removed immediately from Site.

Application

 Unless otherwise specified, paint may be applied by brush or spray. Brushes of appropriate size shall be either round or oval shaped and shall be maintained carefully throughout the work so as to be pliable and free from loose bristle. All brushes, rollers, implements and the like used for painting shall be cleaned of all foreign matter prior beginning different operations.

 Contents of drums and tins shall be well stirred before use and constantly during operations with a small, clean and smooth stick to prevent sedimentation at the bottom of containers.

 Painting shall be carried out, as far as possible, in dry, warm weather.

 Primer coats shall be applied as soon as surfaces have been cleaned and before the deterioration of surfaces by rust and/or contamination by dust, dirt or any other deleterious material. Sufficient time shall be allowed for one coat of paint to dry before the next is applied.

 Painting surfaces shall be protected from sun, rain, condensation, contamination or other surface damage until they are completely dry, 'Wet Paint boards being placed where necessary.

 Surface preparation, the application of priming coats, undercoats and finishing coats shall be carried out as specified below or as recommended by the manufacturer.

 New plaster shall be carefully rubbed smooth and thoroughly cleaned with fresh water to leave dry and smooth surfaces free from dirt. Surfaces shall not be primed or painted until they are completely dry and hard and have been approved by the Owner/PMC.

 Steel surfaces shall be degreased using proprietary brand solvent cleaners approved by the Owner/PMC or mineral turpentine or petroleum and other petroleum solvents, such as trichloroethylene or other equal and approved alkali solutions or detergents.

 De-rusting of steel surfaces shall be done by manual scraping using wire brushes, fine steel-wool, sand paper and the like, mechanically by sand blasting, shot blasting or by flame cleaning or chemical cleaning by methods approved by the Owner/PMC.

 Oil paint shall not be applied to woodwork that is not well seasoned. Surfaces of woodwork to be painted shall be thoroughly dry, clean and smooth and prepared by using coarse and medium grade sandpaper with finished surf aces free from scratches.

 Before applying primers to surfaces of woodwork knotting shall be done with two coats of varnish made by dissolving shellac in methylated spirits of wine or as directed by the Architect.

 Plastered surfaces: Primary coats shall consist of equal parts of white and red lead mixed in boiled linseed oil to the required consistency applied uniformly over surfaces to be painted. When dry, all cracks, holes and other such defects shall be filled with a mixture of one part of white lead and 3 parts of ordinary putty. Surfaces shall then be rubbed with sandpaper and dusted clean and an undercoat thinly applied so that plastered surface is saturated.

 Steel surfaces: Priming coats shall consist of red lead conforming to BIS codes applied uniformly over surfaces to be painted. On old or previously painted surfaces and new surfaces already primed with red lead, surfaces shall be thoroughly cleaned ad primed with red lead on exposed surfaces as necessary or over whole surfaces as directed by the Owner/PMC.

1. Woodwork surfaces: Priming coats shall consist of red lead, white lead, raw and boiled linseed oil and patent dryer applied uniformly over surfaces to be painted. When dry, small holes, cracks, open joints and other minor defects shall be stopped with putty made from whitening mixed to proper consistency with raw linseed oil and white lead to facilitate hardening of putty. Surfaces shall then be lightly rubbed down smooth with sandpaper and dusted clean.

 Finishing coats unless otherwise specified, finishing of all surfaces shall consist of two coats of paint of approved make, colour and shade. The second coat of paint shall give a flat, semi-glossy or glossy finish as specified or as directed by the Owner/PMC and shall present on even appearance and show no brush marks.

1. **Enamel Painting**
2. General

Enamel paint shall conform to the relevant Standards and be of the specified make, colour and shades as approved by shall be obtained directly from approved manufacturers and brought to Site in manufacture & sealed drums and tins for inspection by the Owner/PMC.

Paint for undercoats and finishing coats shall be ready mixed. Mixing by the Contractor shall not be allowed except with the prior written permission of the Owner/PMC, in which case preparation of the ingredients and the control of quality shall be in strict conformity with the manufacturers' recommendations and the relevant Standards and Codes of Practice.

Materials shall be properly stored and protected when not in use with the lids of containers kept tightly closed. Paint in open containers during painting operations shall be covered with a thin layer of turpentine to prevent the formation of skin on the surface.

If required by the Owner/PMC paint supplied by the Contractor shall be quality tested in an approved laboratory as described in BIS codes. Rejected paint shall be removed immediately from Site.

1. Application

Unless otherwise specified, paint shall be applied by brush. Brushes of appropriate size shall either round or oval shaped and shall be maintained carefully throughout the work so as to be pliable and free from loose bristles. All brushes, rollers, implements and the like used for painting shall be cleaned of all foreign matter prior to beginning different operations.

Contents of drums and tins shall be well stirred before use and constantly during operations with a small clean and smooth stick to prevent sedimentation at the bottom of containers.

Painting shall be carried out, as far as possible, in dry, warm weather.

Primer coats shall be applied as soon as surfaces have been cleaned and before the deterioration of surfaces by rust and/or contamination by dust, dirt or any other deleterious material. Sufficient lime shall be allowed for one coat of paint to dry before the next, is applied.

Painted surfaces shall be protected · from suo, rain condensation, contamination or other surface damage until they are completely dry, wet Paint boards being placed where necessary Surface preparation, the application of priming coats, undercoats and finishing coats shall be carried out as specified below or as recommended by the manufacturer.

New plaster shall be carefully rubbed smooth and thoroughly cleaned with fresh water to leave dry and smooth surfaces free from dirt. Surfaces shall not be primed or painted until they are completely dry and hard and have been approved by the Owner/PMC.

Steel surfaces shall be degreased using proprietary brand solvent cleaners approved by the Owner/PMC or mineral turpentine or petroleum and other petroleum solvents, such as trichloroethylene or other equal and approved alkali solutions or detergents.

De-rusting of steel surfaces shall be done by manual scraping using wire brushes, fine steel-wool, sand paper and the like, mechanically by sand blasting, shot blasting or by flame cleaning or chemical cleaning by methods approved by the Owner/PMC.

Enamel paint shall not be applied to woodwork that is not well seasoned. Surfaces of woodwork to be painted shall be thoroughly dry clean and smooth and prepared by using coarse and medium grade sandpaper with finished surfaces free from scratches.

Before applying primer to surfaces of woodwork knotting shall be done with two coats of varnish made by dissolving shellac in methylated spirits of wine or as directed by the Architect.

Plastered surfaces: Priming coats shall consist of equal parts of white and red lead mixed in boiled linseed oil to the required consistency applied uniformly over surfaces to be painted. When dry, all cracks, holes and other such defects shall be filled with a mixture of one part of white lead and 3 parts of ordinary putty. Surfaces shall then be rubbed with sandpaper and dusted clean and an undercoat thinly applied so that plastered surfaces are saturated.

Steel surfaces: Priming coats shall consist of red lead conforming to IS codes applied uniformly over surfaces to be painted. On old or previously painted surfaces and new surfaces already primed with red lead, surfaces shall be thoroughly cleaned and primed with red lead on exposed surfaces as necessary or over whole surfaces as directed by the Owner/PMC.

Woodworker surfaces: Priming coats shall consist of red lead, white lead, raw and boiled linseed oil and patent dryers applied uniformly over surfaces to be painted. When dry, small holes, cracks, open joints and other minor defects shall be stopped with putty made from whitening mixed to proper consistency with raw linseed oil and white lead to facilitate hardening of putty. Surfaces shall then be tightly rubbed down smooth with sandpaper and dusted clean.

Finishing coats: Unless otherwise specified, finishing of all surfaces shall consist of two coats of synthetic enamel paint of approved make, colour and shade. The second coat of paint shall give a flat, semi-glossy or glossy finish as specified or as directed by the Owner/PMC and shall present on even appearance and show no brush marks

1. **French Polishing**
2. Materials

French sprit polish shall conform to BIS codes and shall be made by dissolving 0.15 Kg of best quality shellac, free from resin or dirt in 1 litre of methylated spirit. Suitable pigment shall be added to obtain the required shade or colour.

1. Workmanship

Surfaces to be polished shall be cleaned and all unevenness rubbed smooth with sandpaper, knots, if Visible, being covered with a preparation of red lead and glue. Holes and indentations in surfaces shall be filled with putty made of whiting and linseed oil. Surfaces shall then be given a coat of filler comprising 2.25 Kg of whiting dissolved in .5 litres of methylated spirit. Dry surfaces shall again be rubber down perfectly smooth with sandpaper and wiped clean.

Polish shall be applied by using pieces of clean fine cotton cloth wrapped around cotton wool made into pads. Pads shall be moistened with polish sparingly, but uniformly and completely over the entire surface. When dry a further coat shall be applied in the same way. Finishing shall be carried out with pads covered with a fresh pieces of clean, fine cotton cloth, slightly dampened with methylated spirit, rubbing tightly and quickly with a circular motion, to give a uniform, high class texture.

1. Wax Polishing

 Wax polishing shall be approved quality and make and brought to Site in sealed containers as marketed by the manufacturers.

Woodwork to be polished shall be thoroughly cleaned, stopped and rubbed down perfectly smooth with different grades of sandpaper, the final rubbing done with sandpaper slightly moistened with linseed oil.

Polish shall be applied evenly with clean cloth pads in such a way as to leave no blank patches and rubbed continuously for at least thirty minutes. When surfaces are dry, the second coat shall be applied and rubbed for not less than two hours until surfaces have assumed a uniform gloss, showing no signs of stickiness when touched.

1. Varnishing
2. Materials

Varnish shall be of an approved make and quality.

1. Workmanship

Surfaces to be varnished shall be cleaned and all unevenness rubbed smooth with sandpaper. Knots, if visible, being covered with a preparation of red lead and glue Holes and indentations in surfaces shall be filled with putty made of whiting and linseed oil. Surfaces shall then be given a coat of filler comprising 2.25 Kg of whiting dissolved in 1.5 litres of methylated spirit. When dry, surfaces shall again be rubbed down perfectly smooth with sandpaper and wiped clean.

After preparation of surfaces two coats of clean boiled linseed oil shall be applied and allowed to dry thoroughly. When dry, two coats of varnish shall be applied rally by brush and spread evenly over portions of surfaces with short, light strokes to avoid frothing. Excess varnish shall be scraped out from brushes and varnished portions crossed and laid off lightly. Once varnish begins to set it shall not be touched. If surfaces fail to produce the required gloss, additional coats shall be applied to the satisfaction of the Owner/PMC at the Contractor's cost and expense.

1. Polyurethane Paint

Polyurethane paint shall be of approved make and shall be applied as per manufacturer’s printed specifications.

It shall be a three coat application. It can be done either by using a brush, spray or a roller. It shall be available in variety of decorative finishes i.e. in almost all shades and in glossy and matt finishes. It shall offer the following properties

1. Adhesion to concrete / metal surface/wooden surface
2. Sealing effect against heavy rain
3. Good Water vapor diffusion
4. Weather resistance, color stability, gloss retention and chalk resistance
5. Resistance to disinfectants, chemical, fire, radiation, acid gases, abrasion and wear
6. Low soil adhesion
7. Scratch and Mar resistance
8. Have long life and excellent gloss

It shall absorb UV radiation and shall be easily cleaned of radioactive contamination. The ultraviolet part of the solar radiation shall not affect the coating and thereby shall be long lasting.

1. Materials

Aliphatic grade “Metal coat” applicable for metal surfaces shall be used, comprised of Isocyanides hardener to be used in conjunction with Acrylic Polyol. The colour shall be as approved by the Consultant..

1. Application

Surface shall be properly cleaned and applied with suitable primer as per manufacturer’s specifications. If surface is not smooth, it shall be treated with metal putty and primer.

Two coat of metal coat of thickness 25 to 30 microns shall be applied by spray and finished smooth.

| **Sl. No.** | **Parameter** | **Glossy** | **Matt** | **Remarks** |
| --- | --- | --- | --- | --- |
| 1 | Product composition | PU | PU |  |
| 2 | Pack | Two | Two |  |
| 3 | Shade | As approved |  |  |
| 4a | Viscosity by FC B4 at 30 Deg. C (Seconds)1. Part – A
2. Mix
 | 45 – 5030 – 35 | 45 – 5030 - -35 |  |
| 4b | Application Visosity | 22 – 25 | 22 – 25 |  |
| 5 | Specific Gravity | 0.98-1.2 | 1.16-1.3 |  |
| 6 | Solid Content | 42 – 55 | 55 – 56 |  |
| 7 | Thinner Recommended | 930/000 | 930/000 | Thinner finish |
| 8 | Thinner Intake | 10 – 15% | 10 – 15% |  |
| 9 | Mode of application | Spray | Spray |  |
| 10 | Curing scheduleSurface dryHard dry | 30 MinutesO/N | 30 MinutesO/N |  |
| 11 | Mixing Ratio | 4:1 | 6:1 |  |
| 12 | Finish | Smooth | Smooth |  |
| 13 | Recommended DFT (u) | 25 – 30 | 25 – 30 |  |
| 14 | Gloss (%) | 90 - 90\* | 15 - 20\* | **At 60** |

iv. Melamine Polish

 The melamine polish shall be of best quality and make, as approve`d by the Owner/PMC. It shall be transparent or opaque, as specified by the Owner/PMC.

It shall give silken, smooth finish. The Melamine polish shall have shade and shine, either satin or glossy, as approved by the Owner/PMC. It shall be two component polishes consisting of a base and hardener. It shall be capable of protecting wood from moisture, heat, cold, scratches, stains, cigarette burns etc. It shall have excellent covering capacity. It shall be applicable to all wooden surface of every shape. It shall be applied using brush or spray gun. It shall require lesser time to dry and there shall be no cracks or pealing off of the polish. There shall not be any undulation on the finished surface nor cracks at joints. It shall be of any desired shade as approved by the Architect. It shall have excellent colour, shall be free flowing and shall have good leveling properties. It shall be durable and flexible to absorb cracks. It shall have resistant to scrubs, light rays, heat etc. complete as per architect or Owner/PMC.

Timber works shall be finished by the application of two coats and catalyzed clear lacquer (melamine) wherever it is indicated in the drawing/specified. The finish shall be a stain semi-gloss finish and shall be carried out as follows:-

1. The base shall be sand papered to the desired finish and coated with a colour tings to give it shade. This shade shall be sealed with a coat of spirit finish.
2. After the base, first coat of melamine shall be applied evenly by spray to give as even coat to the veneer surface.
3. After the first coat has fully dried, the surface shall be rubbed down in the direction of the veneer grain with very fine glass paper and left completely smooth and clean before the second coat is applied.
4. When the second coat of melamine is fully dry, the surface shall be rubbed down in the direction of veneer grain with very wire dipped in a petroleum based wax to give lubrication.
5. Twenty four hours after completion of this process the melamine veneer surface shall be finished by burnishing a soft cloth to an approved finish.

v. Texture Paint

The external wall/ internal walls /wooden surface wherever specified in the drawings/schedule of quantities shall be finished with approved textured finish. The specifications shall be as per manufacturer recommendations for the approved products. The sample of shade at textured finish shall be as approved by Owner/PMC.

vi. Acrylic Emulsion Paint

 The internal walls of the building where-ever shown on drawings shall be painted with 100% Acrylic Exterior Emulsion Paint with 3 mm thick putty and applying two coat of weather proof exterior acrylic emulsion paint of approved make over one coat of primer from the same manufacturer after preparation of the surface all as per IS & CPWD specifications & manufacturer’s instructions.

vii. Plaster Of Paris/ Gypsum Plaster Punning

Where specified the walls and ceilings are to be treated with plaster of Paris / Gypsum plaster over cement plaster.

The particular brand of in gradients forming this special plaster and its composition to be used must be previously approved by the Owner/PMC. The entire surface must be of a very smooth surface and minutest unevenness must be removed. Specially trained skilled labour with previous experience of this type work shall have to be employed for the purpose to achieve high grade finish.

## False Ceiling

1. False ceiling using min.12-mm gypsum board, Glass Reinforced Gypsum Decorative type ceiling tiles, and Mineral fibre boards/ tiles, plaster of Paris, cornices/ mouldings, (of thickness as per approved drawings) etc, with metal frame work in grid formation, suspended from RCC ceiling complete including making true horizontal levels etc. as per manufacturer's guidelines.
2. Insulation shall be provided wherever required on the basis of new false ceiling & AIC boxing as per layout requirements. It shall be minimum 50mm thick mineral wool backed with 0.05mm thick aluminium foil & 0.05mmX25mm mesh wire netting fixed with 1.6mm wire ties., A/C boxing with new continuous supply & return air grill, diffusers, shall be provided and fixed and augmented as per the specifications provided complete in all respects.
3. False ceiling with mineral fibre tiles with nominal' size of 600x600 mm shall be provided as per approved drawings specifications & layout requirements.
4. Suspended grid shall be & anodised aluminium or colour coated mild steel T-sections type of panels as per manufacturer's specifications.
5. Ceiling shall be capable for housing all service for electrical, air conditioning, LAN & Fire detection/ Fighting etc. Ceiling shall be finished with Acrylic paint /texture paint / wooden veneer/ laminate as per drawings and details, of approved make and quality.
6. Continuous recess and suspended trough for housing electrical fixtures including any other fixtures as required shall be provided. Stepping and domed profile (having mirror or carbonate sheet finish) as per drawings shall be provided. Cedar wood mouldings out of 20x12 mm and POP cornices out of 50 x 38 mm or with other suitable sizes of cedar wood mouldings & POP cornices shall be provided as per approved drawings & specifications. False ceiling shall be kept free at wall partition junctions.
7. All cut outs, access panels as required shall be provided, easy access for future maintenance and provision to augment the services in future without the need to dismantle work surface and or partition /panel shall be provided. Item shall be complete in all respects as per drawings, specifications and directions of Owner/PMC.

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## Plaster Of Paris (Gypsum Anhydrous) Tiles Ceiling

## Pressed Metal Section Framework For Suspended Ceiling

1. The main load bearing member shall be C shape rectangular tube/ channel with two horizontal 28mm and one vertical 50mm sided and each ends of the C turned down9mm, fabricated of 22 gauge (0.80mm) G.I. Sheet. The cross runner shall be furring channel with 50mm horizontal side, two vertical 10mm and two ends turned flat 15mm onwards, fabricated out of 24 gauge (0.63mm) G.I. sheet. Wall angle shall be 25mm x 25mm, 24 gauge (0.63mm).
2. The hangers or suspenders shall comprise 6mm dia. M.S bars, painted with a coat of steel primer of approved make. These will be fixed to ‘L’ cleats of M.S 25 mm x 25mm x 5mm and 75mm long fixed to the soffit of the of the roof slab with metallic expansion fasteners. The hanger rods of required length shall have threaded end with 2 M.S check nuts at the lower end fixed into holding clamp of size 75mm x 28mm and of manufacturer approved by Owner/PMC, connected with existing AC duct shall be allowing level adjustment. The clamp will hold main runners which shall be running at not more than 1 metre centres in one direction. The cross runner with open side of the channel at top shall be placed below the main runner at right angles at distance as directed by the Owner/PMC but not exceeding 450mm centres in one direction. These will be anchored and screwed properly with main runners at every crossing with a 12 SWG, G.I. wire clip fixed diagonally around the main runner. The cross runners shall be fixed at centres not exceeding 300mm.
3. The wall angles shall be properly secured to walls with rowel plugs and screws and the ends of main and cross runners shall be supported on wall angle

## Mineral Fibre Tiles False Ceiling

1. Standards- Description Reference for Codes In general Shall be as per B.S. or equivalent Indian Suspension system Exposed semi recessed suspension system
* Weight Approximately 3.5 kg / sqm.
* Light reflectance Shall be greater than 83%
* Humidity resistance Shall be about 95% RH
* Fire performance

Reaction Class 0 / Class 1 (BS 476)

Resistance One hour fire rating

* Acoustical criteria

NRC (Noise reduction coefficient) 0.55 to 0.9

* Sound Absorption 0.5
* Sound Attenuation 0.32 decibels
* Thermal conductivity 0.052 to 0.057 W/moK
1. Materials **-**The mineral fibre boards shall be of shall be of approved make, design, shade and quality. The tiles shall be of specified size 600mm x 600mm and thickness as approved. The tiles have straight and square edges and shall be free from any breakages, marks, stains or bends.
2. Framework -The supporting framework shall comprise of sections of specified size and weight as per the requirements of the Employer. The main runner shall be appropriately spaced and fixed to soffit by approved hangers. End hangers shall be at a suitable distance from the adjacent wall.

The cross tees shall be appropriately interlocked (both ways) between main runner to form a required module or grid. The wall angle shall be fixed to the wall at specified space intervals.

1. Workmanship - The ceiling shall be erected in a continuous sequence. All work in this section shall be performed in an efficient manner as per the instructions of the architect and as per manufacturer’s recommended procedures. The assembly shall be of the semi recessed type and shall be designed to meet the needs of performance, durability and aesthetics. The contractor shall make adequate provisions for adequate supports for lighting fittings, making cut-outs and extra framework for light fixtures, A.C. grills, diffusers, speakers, trap doors, sprinklers, sensors, all detectors, etc., complete all as per lay-out / pattern as shown in drawing, as per manufacture's recommendations, as per approved shop drawings.
2. Protection - Prior to installation, the material shall be stored in a dry and clean area which is enclosed and protected from rain or other causes of excessive moisture and stabilised in the area for not less than 24 hours prior to installation.
3. Testing - The false ceiling system installed shall be tested for straightness and levels. The panels shall be true to shape and size as specified and shall be from any bends, scratches or visible marks, patches etc. The framework should be carefully examined for rigidity. If there is any sag, the panels should be dismantled and re-erected complete to the satisfaction of the Owner/PMC. The maximum sag permissible shall be as per that defined in relevant B.S. or equivalent Indian standards.

## Water Resistant Gypsum False Ceiling

1. Standards- Description Reference for codes In general Shall be as per B.S. or equivalent Indian standards.
* Suspension system Exposed semi recessed suspension system
* Weight Approximately 6 kg / sqm.
* Light reflectance shall be greater than 85%
* Humidity resistance shall be about 100% RH
* Fire performance

 Reaction Class 0 / Class 1 (BS 476)

* Thermal conductivity 0.17 W/moK
1. Materials- Water Resistant Glass Reinforced Fibre Gypsum Tiles- The water resistant fibre tiles shall be of approved make, design, shade and quality. The tiles shall be of specified size and thickness. The tiles have straight and square edges and shall be free from any breakages, marks, stains or bends.
2. Framework- The supporting framework shall comprise of sections of specified size and weight as per the specific requirements. The main runner shall be appropriately spaced and fixed to soffit by approved hangers. End hangers shall be at a suitable distance from the adjacent wall. The cross tees shall be appropriately interlocked (both ways) between main runner to form a required module or grid. The wall angle shall be fixed to the wall at specified space intervals.
3. Workmanship- The ceiling shall be erected in a continuous sequence. All work in this section shall be performed in an efficient manner as per the instructions of the architect and as per manufacturer’s recommended procedures. The assembly shall be of the semi-recessed type and shall be designed to meet the needs of performance, durability and aesthetics. The contractor shall make adequate provisions for supports for lighting fittings, making cut-outs and extra framework for light fixtures, A.C. grills, speakers, trap doors, sprinklers, sensors, all detectors, etc., complete all as per lay-out / pattern as shown in drawing and as per manufacture's recommendations.
4. Protection- Prior to installation, the material shall be stored in a dry and clean area which is enclosed and the material shall be allowed to stabilise in the area for not less than 24 hours prior to installation. Also care should be taken such that the material does not bear the weight of any unauthorised loads.
5. Testing - The false ceiling system installed shall be tested for straightness and levels. The panels shall be true to shape and size as specified and shall be from any bends, scratches or visible marks, patches etc. The framework should be carefully examined for rigidity. If there is any sag, the panels should be dismantled and re-erected complete to the satisfaction of the Owner/PMC. The maximum sag permissible shall be as per that defined in relevant B.S. or equivalent Indian standards

## Fire Seals

In order to stop the spread of the fire through the various openings in wall, slab etc. for various services, fire seals suitable as per application are to be used to sustain fire etc. for at least 120 minutes. The same should be used wherever there is pipe crossing, shall not be paid extra and shall be part of Ceiling / Partition / Panelling etc. items.

1. Pipe Wrap -Wherever there is pipe crossing, pipe wrap of approved make to be used. The pipe wrap should be able to prevent the passage of smoke, toxic gases and fire through gaps in compartment walls and floors cause by the collapse and/or melting of combustible services in the event of fire.
2. Fire Collars -Fire collars of approved make are to be used wherever plastic pipes and cables penetrate the fire rated element as per manufactures’ specifications.
3. Fire Barrier -Fire barriers of approved make to be used to prevent spread of fire through openings in fire resistant walls and floors where these are used for passage of cable tray, ducts etc.

## Roof Sheeting Works

1. **Material**

Embossed polycarbonate sheets of required thickness, in clear required colour, both side uv equivalent coating of 40 microns, with one surface plain and having granular embossing on one surface, light transmission - 72%, impact strength of more than 200 joules.

1. **Laying**

To be fixed over a MS structure with aluminium channels –alcox fittings (top plate and bottom plate to be fixed with a self-tapping screw) and epdm gaskets. all junctions shall be sealed with silicone sealants to achieve complete water tightness of the whole system.

1. **Technical data**
2. Polycarbonate sheets : as per IS codes

High Impact Strength : >200Nm (falling dart test)-Virtually unbreakable

Good Weather-ability : Continuous temp. (40oC) to (+100oC)

UV Protection : Avoids discoloring

Light Weight : Sp. Gravity – 1.2

Design Freedom : Can be cold bended/curved

1. EPDM Rubber Gasket

With Hardness : as per ASTM-D2240 and specific

Gravity as per ISO-2781 strength per ASTM-D412

1. Aluminum Section : as per IS codes Alloy – 6063 with tempering T6
2. MS Square/Rectangular : as per IS codes with YST-section 240.

## Cement Based Polymer Adhesive

(All Adhesive Shall have VOC limits as per LEED GOLD guidelines)

1. Tile adhesive complies with the BS: 5980 with latest edition. The adhesive shall be polymer modified cement based adhesive. The adhesive should be able to fixing tiles, natural stones in exterior and interior use including swimming pool.
2. Adhesive should be able to improve adhesion, reduce water permeability and widen application. It should be able to fixing upto 6 mm thickness.
3. It should possess low shrinkage and should be flexible to accommodate physical and thermal movements.
4. It should be able to use for indoor and outdoor application.

## Cementitious Grout

1. The grout shall be of high quality, water resistant, cement based powder grout for grouting ceramic tile, vitrified tile, industrial tile etc.
2. It should be available in all colors to match the tile color. It should have high strength for maximum load bearing. It should be non-shrink, non-bleeding and non-segregating at fluid consistency.
3. It should not contain any chlorides and or additives which may contribute the corrosion of the structure.
4. It should be weather resistant, non-cracking, non-shrinking. The compressive strength, linear shrinkage, tensile strength and flexural strength should be according to the BS codes.

## Epoxy Grout

1. It should be hygienic, hard wearing, impervious, epoxy resin based ceramic tile grout with a high degree of resistance to chemical attack, abrasion and impact.
2. The grout should not transfer taints to food stuffs and should not permit the entry of bacteria or dirt and easily maintained in a sterile condition.
3. It should be available in all colors to match the color of the tile color. It should attain very good early strength. It should possess good chemical resistance to acid, alkalies etc.
4. It should possess good tensile and flexural strength and it has a very good dynamic load resistance.

## Lacquered Glass

Providing and fixing of 6 to 8 mm thick lacquer glass of approved make , color with clear neutral silicon of approved make on a perfectly levelled water proof non-conventional plywood (preferably marine plywood) of minimum 12mm thickness, mounted on the RCC wall/any other structure. The lacquered glass to be of 8mm thick highly durable, humid resistance, poly urethane lacquer glass. The glass should be manufactured by industrial curtain coating process. Lacquered glass to be manufactured to right specifications, relating to consistency of color, opacity and homogeneity throughout production campaigns and also to the ageing properties, mechanical resistance, and resistance to humidity and to chemical agents of the lacquer. The color of the lacquer should remain stable when exposed to normal levels of ultra-violet light in interior applications. Permissible tolerances in the color measurements, on the glass side:

Δ L \* ±0.5

Δ has \* ±0.5

Δ B \* ±0.5

Δ E\*ab < 0.5

The value Δ E\*ab is an average value of measurements taken from the same production run. The color-meter used is normally a MINOLTA spectrophotometer CM508I (as per standard test conditions). Manufacturer certificate to be provided.

## 3m Frosted Film

## Physical Characteristic

|  |  |
| --- | --- |
| Characteristic | Description |
| Film | Cast vinyl, glossy finish |
| Opacity | Opaque |
| Thickness | Without adhesive: 3.25 mil (0.09 mm) With adhesive: 4 mil (0.1 mm) nominal |
| Colors | No. Color404 Yellow Orange405 Yellow406 Green407 Blue413 Fuchsia414 Red Orange |
| Adhesive type | Pressure sensitive |
| Adhesive color | Gray |
| Liner | Kraft paper, white |
| Tensile strength | 5 pound/inch at 73°F (0.9 kg/cm at 23°C) minimum |
| Adhesion24 hours after application | Acrylic: 4 pounds/inch (0.7 kg/cm) Glass: 4 pounds/inch (0.7 kg/cm) Polycarbonate: 4 pounds/inch (0.7 kg/cm) |
| Chemical resistance | Resists mild alkalis, mild acids, and saltExcellent resistance to water (this does not include immersion) |

## Application Characteristic

|  |  |
| --- | --- |
| Characteristic | Description |
| Finished graphic application recommendation | Graphic orientation: VerticalSurface type: Flat with and without rivetsSubstrate type: Glass, acrylic, polycarbonate, fiberglass, painted metalApplication method: Dry |
| Applied film shrinkage | 0.010 inch (0.3 mm) maximum |
| Finished graphic exposure temperature | -40 to +225F (-40 to +107C) |
| Graphic removal | None, permanent |

## 3M Scotachcal Film

Characteristics These are typical values for unprocessed product. Processing may change the values. Contact your 3M representative for a custom specification.

|  |  |  |
| --- | --- | --- |
| Physical Characteristics | Characteristic | Value |
|  | Film | Vinyl, cast |
| Film colour | White, opaque |
| Thickness | Without adhesive: 0.05 mm With adhesive: 0.08-0.10 mm |
| Adhesive | Films IJ180 (all versions): Pressure-activated, slideable, repositionableFilms IJ180C, IJ180Cv3: Pressure-activated, slideable, repositionable, air release channels |
| Adhesive colour | Grey |
| Liner | Polyethylene-coated paper |
| Adhesion, Typical24 hours after application | Substrate | Adhesion |
| Aluminum, anodized | 27N/25mm |
| Tensile strength | 22N/25mm at 23°C |
| Chemical resistance | Resists mild alkalis, mild acids, and saltExcellent resistance to water (does not include immersion) |

Application Characteristics

|  |  |
| --- | --- |
| Finished graphic application recommendation | Surface type: Flat, with and without rivets, simple curves, moderate compound curves, and corrugationsSubstrate type: ABS resins, aluminum, chrome, glass, fiberglass reinforced plastics, paint (check adhesion to powder-coated or water-based paints) fiberglass with gel coatApplication temperature: Flat without rivets: 4-38C (40-100F) Curves or corrugations with rivets: 10-38C(50-100F) Compound curves and/or watercraft: 16-32C (60-90F)Application method: Dry |
| CleaningImportant Notice | Isopropyl Alcohol is not a recommended cleaning product for vehicle wrapping: becauseit evaporates too quickly, IPA (Isopropyl Alcohol) is not an appropriate cleaner. 3M Surface preparation system is the only 3M recommended cleaning product. |
| Applied shrinkage | 0.4 mm (0.015 inches) |
| Temperature range after application | -60 to +107C (-65 to +225F) |
| Graphic removal | Removable with heat and/or chemicals from most substrates within the warranty period at 10C (50F) minimum (air and substrate) |

|  |  |
| --- | --- |
| Application and Installation | Install the film using the dry application method.Refer to the 3M Related Literature section, located at the end of this bulletin, for a list of the Instruction Bulletins that may be needed to apply or install this film. |
| Adhesive All films in this Bulletin | This film has a pressure-activated that allows the film to slide easily on the substrate, be positioned with light finger design so that a good adhesive bond is established, the position ability feature is lost:  when firm pressure is applied with a squeegee or other application tool at application temperatures above 38C (100F) even if only light finger pressure was used for tackingif any part of the film is removed from the original liner and reapplied to the same or another linerSolvent from piezo inkjet ink that has not completely dried and is retained by the film also affects slide ability and position ability. |
| Films IJ180C, IJ180Cv3(all versions) with Comply™ Adhesive | These films also have air release channels, a characteristic of Comply adhesive. Removing and attempting to change liners or reapply the same liner damages air release channels.Always work from the center out to the edges of the graphic to allow trapped air to exit through the air release channels. If the channels are closed off by firm pressure and air is trapped, use an air release tool to aid in removing air bubbles. See Instruction Bulletin 5.4 for details. |
| Graphics Printed with UV Piezo Inkjet Inks are Heat Sensitive! | UV piezo inkjet inks may crack if too much heat is used during graphic application to complex curves and deep contours as well as around rivets. When using a heat gun or other heat source during application, makesure the film surface temperature does not exceed 100C (212F) for prolonged periods.Using additional heat in the post-application process may also cause UVpiezo inkjet ink to crack.For the best results, always do a test application of a UV piezo printed graphic to determine how much heat can be used without damaging the image. |
| Maintenance andCleaning | Use a cleaner designed for high-quality painted surfaces. The cleaner must be wet, non-abrasive, without strong solvents, and have a pH value between 3 and 11 (neither strongly acidic nor strongly alkaline.) |

## Wood Work And Joinery

The Contractor shall be responsible for providing all plant, tools, materials, labour and all things necessary for the proper execution, completion and maintenance of the works.

## Timber

Timber used for joinery shall be the best of its respective class, seasoned for a minimum of six months by air-drying, of natural growth and free from defects such as cracks, splits, shakes, dead knots, soft spongy spots and waves of injurious open stakes. When one kind of timber is used it shall be of uniform colour to the satisfaction of the Architect.

Grains shall be reasonably larger than 6 square centimetres and the aggregate of all knots shall not exceed 0.5% area of any one piece.

Timber shall be kiln dried to IS codes and conform to IS codes in regard to moisture content. The maximum permissible limit shall be +3% for the average moisture content of all samples from a given lot and +5% from individual samples from a given lot. This shall apply when the thickness of timber is more than 50mm. Small size timber tolerances shall be +/- 2% and +/- 3% respectively.

The Contractor shall provide samples of all timber and other materials to be used in the work for the approval of the Architect. All timber and other materials brought on to the Site shall strictly comply with the approved samples.

Timber shall be seasoned, chemically treated and treated with a 10 (ten) year guaranteed and approved anti-termite treatment to render it free from decay and insect attack.

The moisture content of the timber during manufacture, delivery to site, storage, site working, assembly, installation shall be 10 to 12 percent.

Timber shall be hardwood, shall be FSC certified and shall be suitable for the purpose for which it is intended. It shall be seasoned or Kiln dried, absolutely free from worm holes, large loose or dead Knots or other defects which would effect strength or usability and shall be flat, straight non-splitting and dressed on all sides. It shall be matched for colours and graining.

Recycled wood or rapidly renewable wood can also be used such as poplar, eucalyptus, bamboo etc only after confirmation of Owner/PMC.

## Doors

Doors shall be solid core flush doors as described, external flush doors being made with weatherproof plywood. Flush doors shall conform to IS codes and commercial veneers and laminates shall conform to IS codes. and shall be obtained from approved manufacturers. The solid core shall be wood laminates prepared from battens of well-seasoned and treated good quality wood having straight grains.

The finished thickness of the door shutter shall not be less than 40mm and door frame size shall not be less than 75mm x 120mm.

Decorative veneers shall be Grade 1 and conform to the requirements for decorative veneers specified for Grade 1 decorative plywood interior grade with a thickness not exceeding 1 mm.

Lippings shall be of best quality hardwood. Teak lippings, where described, shall conform to the specification for best quality teakwood. Lippings around doors shall be of one piece not less than 25mm wide with a depth equal to the door thickness. Double leaf doors shall have lippings on the meeting stiles not less than 35/40 mm deep.

Approved plastic or laminated veneers shall be provided where specified and fixed with “Fevicol” or other equal and approved adhesive. Finished surfaces shall be thoroughly cleaned with wax polish.

All hardware shall be of approved finish, shade, specification, type as provided in the Tender document.

## Windows

Windows shall be as specified and, unless otherwise described, shutters shall have one pair of hinges, two tower bolts (one 225mm long and the other 150mm long), one handle and one hook with eye and a pegstay. Ventilators shall have two mild steel holdfasts and hinges, one handle and one hook and eye at each end with one tower bolt in the centre.

## Cupboards And Cabinets

Cupboards, wooden cabinets shall be provided as per approved drawings. Doors may be either hinged type or sliding type as detailed.

The cabinetry shall be in 19mm thick marine grade plywood frame work as per the detailed drawings. Intermediate shelves /drawers shall be made in 19/12mm thick marine grade plywood frame work, the drawers shall be provided with imported telescopic drawer channels of approved make. All the exposed wooden surfaces shall be stained to shade as directed by the Consultant/ Owner/PMC and polished melamine. This also includes providing necessary handles, hinges, tower bolts, ball catches, locks etc. of approved make.

## Architraves

Railings and architraves shall conform to the shape shown on the drawings or as approved by the Consultant/Owner/PMC and fixed by means of screws, counter- sunk or otherwise, or bolts.

## Glazing In Windows, Doors

Glazed windows, louvers, ventilators and doors shall be provided with either clear, float or pinheaded glass 5.5mm thick or as otherwise described, shall be free from all blemishes and conform to IS codes.

## Ironmongery And Fittings

Fittings and fixtures and other ironmongery shall be as detailed drawing and shall comply with the relevant IS Standards and Codes of Practice.

All nails, screws, fixings, and the like shall be of hot dip galvanized or brass or non-ferrous material as described.

## Workmanship

1. **General**

Workmanship shall be of the best quality and the Contractor shall check all dimensions on Site prior to putting joinery work in hand.

All joinery work shall be accurately set out in strict accordance with the drawings and shall be framed together in the best possible manner and with the best possible method of jointing.

No timber shall be painted, tarred, oiled or the like before it has been inspected by the Consultant /PMC. Any effort to hide defects by plugging, painting and the like shall lead to the timber being rejected by the Consultant/PMC. All rejected timber shall be immediately removed from the Site.

Thickness specified for wrought timber are, unless otherwise specified, prior to planning and an allowance of 3mm shall be made for wrought faces.

Sawing and planning of timber shall be done in straight lines and planes to produce uniform thickness. Joinery work shall be wrought on all faces and finished off by hand with sandpaper with slightly rounded arises.

Before joining wood frame members shall be planed smooth and accurate to the final size. Rebates, roundings, mouldings and the like shall be made before the members are jointed.

Mortice and tenon and dovetailed joints as required shall be strong, neat and shall fit without wedging and/or filling. Joints of frames shall be pinned with 10 to 15mm diameter hardwood pins and white lead after the members have been glued and pressed together.

Joinery work which splits, fractures, shrinks or shows flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship shall be immediately removed and replaced with sound material at the Contractor’s own cost.

1. **Door and Window Frames**

Door, window and ventilator frames, transoms and mullions shall be rebated. Top frame members of doors and top and bottom frame members of windows and ventilators shall project about 150mm in brickwork. Vertical members of door-frames shall project about 50mm below finished floor levels.

Door and window frames shall be provided on each side with 3 nos. 225 x 25 x 6mm mild steel flat split hold-fasts which shall be built into masonry or cast into concrete work in accordance with IS codes.

Frames shall be finished smooth to receive paint, polish or any other specified finish. Surfaces of timber fixed to masonry or concrete shall be painted with hot bitumen coal tar or any other approved wood preservative or primer before being placed in position.

1. **Door and Window Shutters**

Door and window shutters shall conform to the requirements of IS codes If required, flush door panels shall be tested in accordance with the requirements of IS codes.

All faces of door and window shutters shall be at right angles, free from twist and warp in the plane. Faces shall be sanded to obtain a smooth, even texture.

Shutters shall be painted on the commercial side with two coats of synthetic enamel paint over an approved coat of primer. Decorative veneer sides shall be wax or French or Melamine polished with two or more coats as specified.

Double leaf shutters shall have meeting stiles rebated 20mm deep and shall be either splayed or square type with teak wood lipping not less than 35/40 mm deep.

Care shall be taken to prevent damage of any kind or loss of shape during transport, handling, stacking and hanging.

##  Fixing

The carpentry timber shall be fixed with nails, spikes, bolts screws, hangers, stirrups, anchors, ties or any other accessories which are suitable to develop the full strength of the member to which they are attached, as directed.

Carpentry timber where fixed to solid masonry or concrete shall be secured with expansion bolts or other positive methods of mechanical fastening. MS hold fast grouted in CC block shall be used to hold the door frames.

##  Timber - Treatment

All timber shall be protected with an organic solvent water repellent wood preservative to give a highly efficient protection against termite, spider, worm, all insects and fungus and rot attach and shall, where exposed, enhance the appearance of the timber. Colour of the product shall be such as to bring out the natural colour of the respective timbers. Fire retardant paint to timber shall be applied as per the recommendations of manufacturer and shall comply with the requirement of IS. code and local fire requirements.

## Plastic Laminate

Plastic decorative laminate sheeting shall be of the approved make, colour, shade and texture. Plastic laminate shall be fire retardant to class I of BS:476 code where specified. The thickness shall be 1mm /1.5mm and shall be fixed on to doors/ partitions/ paneling/ boxing etc. with approved adhesive and tapes. Laminate to be fixed in panels of width as specified in drawings including wood edge margin/ laminate on panel edges and grooves behind complete in all respect as per direction and specification/ details and as directed by architect. All grooves to be finished in melamine polish in matching color of laminate

## Veneers

Veneer shall be of the timber species of shown on drawings. Veneers are to be kept in sequence as they are being cut from wood and supplied as such to the site for accurate matching or figuring. The veneer shall be finished as specified and shall be equal or superior quality to that laid down in IS codes or as approved.

## Plywood

All ply wood shall be of best / high quality close grained suitable for veneering, painting or bonding plastic laminate. The thickness shall be as specified in drawings or as approved by Owner/PMC. It shall be resin bonded and weather proof. Exposed edges shall be finished with an edge strip of solid teak wood. tongued and grooved and glued , or as detailed. The plywood of approved brand and manufacture only shall be used in the work. The thickness shall be in accordance with the drawings /schedule of quantities.

## Medium Density Fibre Board

For Interior Works MDF of approved make /manufacturer shall be of only exterior grade as per IS codes.. It is to be contained that MDF shall be invariably used in place of Ply / Boards .so specified in the specifications of either same thickness or of higher thickness .wherever feasible The minimum thickness of MDF to be used shall be 8mm. Wood screws are not to be used for MDF and only fully threaded parallel shank screws shall be used after drilling pilot holes. Veneering /lamination to the MDF surface shall be done by exterior grade adhesive only. Polyurethane primers shall be used for sealing the edges and painting the rear side. For specifications of various applications the manufacturer users manual shall be followed.

1. **Adhesives:-**

The adhesives used for all wood work and MDF shall be of approved make of appropriate Grade with Low VOC content as per IS codes requirements. Manufacturer’s recommendations shall be followed for adhesive other than above required for any specified / specialized work.

1. **Joinery:-**

Joinery shall be carried out strictly in accordance with the drawings, where joints are not specifically indicated recognized forms of joints shall be used. Joinery shall conform to IS Standards.

Panels shall be rendered flame retardant and to conform to local fire regulations.

The Contractor shall submit samples of all materials including samples of veneer for approval.

All materials pre-fabricated, delivered and assembled shall be in accordance with the approved sample.

The Contractor shall be responsible for protecting all items of wood-work done by him. The contractor shall replace at his own expense any damaged work caused through lack of adequate protection or care in installation or handling.

## Mirrors and Glasses

Mirrors shall be fabricated from best clear plate or float glass of approved quality in imported variety and shall match the International Standards. All fixed panel mirrors shall be +/- 0.30mm tolerance. The edges of mirrors shall be polished and bevelled and mitred as per IS specifications wherever, it’s indicated in the drawing.

All vision glasses shall be float glass of minimum 5mm thickness or as specified thickness. The edges shall be bevelled as indicated in drawings and shall be done at approved source.

The Etching wherever specified in drawings, shall be done at approved sources as per full-scale drawing approved by the Owner/PMC. The etched panel shall be chemically washed /treated as per specialist specifications to have a permanent dust free surface.

The Contractor shall be responsible for protecting all mirrors and glasses fixed by him and shall replace at his own expense any broken or damaged mirror / glass caused through lack of adequate protection or care in installation or handling.

## Fire Doors General Specifications

**1. Fire Doors (General)**

Fire resisting, means that the construction is designated as capable of resisting the passage of flame and smoke, and providing insulation as defined in under the prescribed conditions of test appropriate to such construction in accordance with the current Indian Standard codes.

**2. Scope**

This specification covers the design, supply of materials, Manufacture and installation of factory made special type of approved make fire doors of 1 Hour, 2 Hrs. Fire Rating with all accessories and including supply and installation of hardware

**3. Codes and Standards**

All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

**4. General**

The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.

All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural proprieties to withstand safety strains, stresses to which they shall normally be subjected to.

All fittings shall be of high quality and as specified and as per approval.

The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard codes and the provisions of the safety code and the provision of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.

Any approval, instructions, permission, checking, review, etc., whatsoever by the Owner/PMC, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

**5. Hollow Metal Fire Door (2 Hours Fire Rating) with Honey Comb Core**

Fire door shall be 2 hour fire rated and door quality shall be approved and tested conformed to Indian Standard Codes and NBC-2016 requirements.

* + 1. **Frame**
* Material - Frame to be manufactured from 1.60 mm (16 gauge) galvanised steel sheets complying with latest IS Code coating class zinc coating mill phosphatized.
* Profile - Door frame profile to be double rebated of dimensions 143 mm X 57 mm (+/- 0.3) with bending radius of 1.4 mm.
* Manufacture - Frame to be manufactured from 1.60 mm thick galvanised steel sheet to the specified profiles and dimensions. Frames manufactured at factory shall be knock down form with butt joints for bolted assembly at site.
* Door frame preparations – Frames to be provided with a 3 mm thick back plates on all jambs with provision for anchor bolt fixing to wall openings. All frames to have reinforcement pads for fixing of door closer, at appropriate location as per manufacturer’s details.
* Frames to have factory finish-pre-punched cut outs to receive specific hardware and iron mongery.
* Frames to be provided with hinge plates 3 mm thick pre-drilled to receive hinges for screw mounted fixing. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement, dust ingress into cut outs at the time of grouting.
* Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.
* Finish Door frames to be suitably cleaned with solvents and etch primered for receiving primer and top coats. Door frames to be primered in zinc phosphate stoving primer (35 microns DFT). Door frames to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.
	+ 1. **Fire door shutter**
1. Material - Fire door shutter to be manufactured from 1.20 mm (18 gauge) galvanized sheets conforming to latest to Indian Standard Codes and NBC-2016 requirements, coating class zinc coating, mill phosphatized.
2. Manufacture - Shutters to be press formed to 46 mm thick double skin hollow door with lock seam joints at stile edges. Shutters to have no visible screws or fasteners on either face. Internal reinforcement to be provided at top bottom and stile edges for desired fire rating.
3. Door Shutter Cores – Shutters to be provided with honeycomb Kraft paper core to be bounded to the inner faces of the shutter.
4. Door shutter preparations – Shutters to be factory prepared with pre-punched cut outs and reinforcements to receive iron mongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.
5. Shutters to have pre-drilled hinge plates with hinge guard covers. Shutters with locks to have concealed lock box with lock fixing brackets with pre-tapped holes.
6. For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer’s design.
7. All ironmongery preparation to have adequate reinforcement for flushes fixing at site.
8. Vision panel for Fire rated door- Vision panel to be provided with Borosilicate clear toughened glass of the thickness 6 mm for upto two hours fire rating. Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels and Glazing Tape with one side adhesive. Vision Panels to be fixed with clip-on frames for square and rectangular Vision Panels with no visible screws. Unless otherwise specified standard sizes are 200 mm x 300 mm and 380 mm diameter.
9. Finish - Shutters to be suitably cleaned with solvents and etch primered for receiving primer and top coats. Shutters to be primered in zinc phosphate stoving primer (35 microns DFT). Shutters to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.
10. Packing - Frame -Individual frames members to be wrapped in protective 70 micron polyethene sheets and placed in individual card board boxes. Individual boxes to be sealed. Frames to be assembled at site with aid of roofing bolts.

Shutters- Shutters to be wrapped in protective 70-micron polyethene sheets and packed in card board and duly strapped. All frames and shutters duly marked as per door schedule for easy identification at site.

1. STORAGE - All knocked down frames shall be stacked flat and shutters vertically on wooden runners and suitably covered as per the instructions of manufacturer to prevent rust and damage.

## Gypsum Board Acoustic Partitions

The partition system shall be provided and fixed as per approved drawing and specifications. It shall have insulating material for best desired acoustical values and raceways for wire management with outlets for convenient access to automation facilities as per the approved drawings and specification.

75 Mm Thick Full Height Both Side Gypboard Partition - Height: From FFL till True/structural ceiling Lvl Providing & fixing in place Partitions of overall thickness of 75 mm, formed out of the following components.

Providing and fixing partition upto ceiling height consisting of G.I. frame and required board, including providing and fixing of frame work made of special section power pressed/ roll form G.I. sheet with zinc coating of 120 gms/sqm(both side inclusive), consisting of floor and ceiling channel 50mm wide having equal flanges of 32 mm and 0.50 mm thick, fixed to the floor and ceiling at the spacing of 610 mm centre to centre with dash fastener of 12.5 mm dia meter 50 mm length or suitable anchor fastener or metal screws with nylon plugs and the studs 48 mm wide having one flange of 34 mm and other flange 36 mm and 0.50 mm thick fixed vertically within flanges of floor and ceiling channel and placed at a spacing of 610 mm centre to centre by 6 mm dia bolts and nuts, including fixing of studs along both ends of partition fixed flush to wall with suitable anchor fastener or metal screws with nylon plugs at spacing of 450 mm centre to centre, and fixing of boards to both side of frame work by 25 mm long dry wall screws on studs, floor and ceiling channels at the spacing of 300 mm centre to centre. The boards are to be fixed to the frame work with joints staggered to avoid through cracks, M.S. fixing channel of 99 mm width (0.9 mm thick having two flanges of 9.5 mm each) to be provided at the horizontal joints of two boards, fixed to the studs using metal to metal flat head screws, including jointing and finishing to a flush finish with recommended jointing compound, jointing tape, angle beads at corners (25 mm x 25 mm x 0.5 mm), joint finisher and two coats of primer suitable for board as per manufacture's specification and direction of Owner/PMC all complete.

Provide an additional hollock wood/Sal wood member of 50mm x 50mm x 100mm/75mm treated with anti-termite and fire retardant paints as spacer at the true ceiling level and sub frames for doors and glazed openings while fixing the frame work as per details.

Providing and fixing thermal insulation with Resin Bonded Fibre glass wool conforming to IS: 8183 having density 24 kg/m3, 50 mm thick, wrapped in 200G Virgin Polythene Bags fixed to wall with screw, rawel plug & washers and held in position by criss crossing GI wire etc. complete as per directions of Owner/PMC.

## Steel Works

**1 Rolling Shutters**

Rolling shutters shall be in extruded galvanized sections, of approved make, type and finish. These shutters shall be complete with locking arrangements, hoods, guides, pulling devices, springs and other accessories. Wherever specified, mechanical device shall be fixed for easy operation of the shutters.

**2 Steel Door / Window**

Hot rolled steel sections for fabrication of steel doors, windows, ventilators and fixed lights shall conform to IS codes. Shapes weights and designations of hot rolled sections shall be as per IS codes indicates the purpose or the situation where the sections are normally used. Tolerance in thickness of the sections shall be+0.2mm.

The steel doors and windows shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening to allow for easy fitting of doors windows and ventilators into opening. The actual sizes of doors, windows and ventilators shall not vary by more than +1.5mm from those given in the drawing.

* **Fabrication**
1. Frames - Both the fixed and opening frames shall be made of sections which have been cut to length and mitred. The corner of fixed and opening frames shall be welded to form a solid fused welded joint conforming to the requirements given below. All frames shall be square and flat. The process of welding adopted shall be flash butt welding. The section for glazing shall be tennoned and riveted into the frames and where they intersect the vertical tie shall be broached and horizontal tee threads through it, and the intersection closed by hydraulic pressure.
2. Requirements of welded joints
* Visual Inspection Test

When two opposite corners of the frame are cut, paint removed and inspected, the joint shall conform to the following:

* Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.
* Welds should have been properly grounded and
* Complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.
* Micro and Macro Examinations

From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and reasonably free from under cutting, overlaps, gross porosity and entrapped slag.

* Fillet Weld Test

The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

* **Door**

The hinges shall be of 50mm projecting type, Non-projecting type hinges may also be used if approved by the Owner/PMC. The hinge pin shall be of electro-galvanized steel or aluminium alloy of suitable thickness and size. Door handles shall be approved by the Owner/PMC. A suitable latch locks for door openable both from inside and outside shall be provided.

In the case of double doors, the first closing leaf shall be the left hand leaf locking at the door from the push side. The first closing shutter shall have a concealed steel bolt at top and bottom. The bolts shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter door may be provided with a three way bolting device. Where the device is provided in the case of double shutters, concealed brass or steel bolts shall not be provided.

* **Windows**
1. For fixed windows, the frames shall be fabricated as per relevant IS codes specifications.
2. Side hung windows.

For fixing steel hinges, slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame at the back. The hinges shall be of projecting type with thickness not less than 3.15 mm and length not less than 65mm and width not more than 25mm. Non-projecting type hinges may also be allowed if approved by the Owner/PMC. The diameter of hinge pins shall not be less than 6mm. The hinge pin and washer shall be of galvanised steel or aluminium alloy of suitable thickness.

For fixing hinges to inside frame, the method described above may be adopted but the weld shall be cleaned, or the holes made in the inside frame and hinge revetted.

The handle of side hung shutters shall be pressed brass, cast brass, aluminium or steel protected against rusting and shall be mounted on a steel plate. Thickness of handle shall not be less than 3 mm in case of steel or brass and 3.5mm in case of aluminium. The handle plate shall be welded, screwed and/or riveted to the opening frame in such a manner that it should be fixed before the shutter is glazed and should not be easily removable after glazing.

The handle shall have a two point nose which shall engage with a brass or aluminium alloy striking plate on the fixed frame in a slightly opened position as well as closed position. The boss of handle shall incorporate a friction device to prevent the handle shall incorporate a friction device to prevent the handle from dropping under its own weight and the assembly shall be so designed that the rotation of the handle may not cause it to unscrew from the pin.

The height of the handle plate in each type of standard windows will be as specified. Otherwise it shall be at a height of 3/8 of the height of shutter, from its bottom. The strike plate shall be so designed and fixed in such a position in relation to the handle that with the later bearing against its stop, there shall be adequately tight fit between the casement and outer frames.

In case where no friction type hinges are provided, the window shall be fitted with peg stays which shall be either of black oxidised steel, pressed or cast brass or as specified, 300mm long with steel peg and locking brackets. The pegs stay shall have three holes to open the side hung casement in three different angles. The peg stay shall be of minimum thickness 2mm in case of brass or aluminium and 1.25mm in case of steel. Where specified friction hinges shall be provided. Side hung shutters fitted with friction hinges shall not be provided with a peg stay.

If specified, side hung shutters maybe fitted with an internal removable fly proof screen in a 1.25mm thick sheet steel frame to the outer frame of the shutter by brass turn buckles at the jambs, and brass tads at the sill to allow the screen being readily removed. The windows with removable fly proof screen shall be fitted with a through – the – screen level operator at the sill level to permit the operation of the shutter through an angle of 90o without having to remove the fly proof screen. The lever shall permit keeping the shutter open in minimum three different position.

* **Glazing**

Specifications as described shall apply. The glass panes shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. In doors, windows, clerestory windows of bath, WC and lavatories frosted glass panes shall be used.

Glazing shall be provided on the outside of the frame unless otherwise specified. Putty of approved make conforming to IS codes shall be used for fixing glass panes. Putty shall be applied between glass panes and glazing bars. Putty shall then be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the back rebate to enable the painting to be done upto the sight line to seal the edge of the putty to the glass. The oozed out putty shall be cleaned and from putty cut to straight line. Quantity of putty shall not be less than 185 gm/metre of glass perimeter. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its cracking.

Note: Putty may be prepared by mixing one part of the white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to from a stiff paste and adding varnish to the past at the rate of 1 litre of varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste.

Minimum six glazing clips to be provided per glass pane of all types. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced, according to the slots, in the vertical members provided the spacing does not exceed 30cm otherwise the spacing shall be 30cm.

Note: Where large size glass panes are required to be used or where the door window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages.

Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading.

Where metal beading is specified extra payment shall be made on this account.

**3. T-Iron / Angle Iron/ Pressed Steel Doors Frames**

T-iron / Angle Iron/ Pressed steel doors frames shall be manufactured from uniform mild steel tee section / angle section / pressed steel. The steel shall be of approved grade. The frames shall be got fabricated in approved workshop as approved by the Owner/PMC.

The sizes of door frames shall be as per drawing or as decided by the Owner/PMC. MS tie bar of 10mm dia shall be welded at bottom of the frame. The size of doors shall be calculated so as to allow 12.5mm clearance on all sizes to allow an easy fittings in opening. The actual size of doors, windows and ventilators shall not vary by more than +/- 2mm than those shown in the drawing.

The size of T-section / Angle section / Pressed steel used for manufacture of doors, windows and ventilators shall not be less than those specified in IS codes. Unless otherwise directed by the Owner/PMC.

* **Fabrications**

The frame shall be constructed in section which has been cut to length and metered. The corners of the frames shall be butt welded to form a true and right angle. All frames shall be square and flat.

The T-section / Angle section/ Pressed steel shall be mitre joined and continuously butt welded all along.

* **Fittings**

Requisite number of holes shall be made in the frame for fixing of fittings. Detailed arrangements of fixing fittings shall be as shown. All fittings shall be fillet welded to T-iron / Angle iron frame/ Pressed steel all along the periphery of contact.

Butt hinges shall be fixed to the frame as below:

1. MS flat of size 100mm x 25mm x 6mm will be welded with fillet weld all along the periphery of contact on the rear side of the web of T-iron / Angle iron/ Pressed steel to receive the hinges. Requisite number of holes shall be made in T-iron / Angle iron frame/ Pressed steel and MS flat for fixing of hinges with counter sunk steel screws as shown.
2. An alternate method of fixing butt hinges can be adopted by fillet welding the hinge to the T-iron / Angle iron/ Pressed steel frame on three sides. No welding shall be done along the hinge pin to allow free movement of butt hinges as shown.
* **Fixing Procedure**

Fixing procedure for T-iron / Angle iron/ Pressed steel doors, windows and ventilator frames in masonry opening shall be as shown in the drawing.

## Aluminium Work

**1 General**

This specification applies to the Aluminium Doors and Window works to be executed by the contractor. It is to be read in conjunction with and subject to the general and special conditions of contract and in conjunction with the drawings, the schedule of rates and such other documents as may vary from time to time be agreed upon as comprising part of this contract.

This section covers the aspects of technical performance, product specifications, and execution and time warrantee for the works shown or specified.

The exterior wall system requirements shown by the details are intended to establish dimensions of units or modules and maintain the visual design concept as shown. The exterior wall system manufacturer shall be required to design the entire exterior building wall system, and to make whatever modifications of and addition to, the details as may be required to fulfill the performance requirements. The system consists of all anchors, window, glazing, sealants and other components required for a complete system as indicated on drawings including framing as required to support the system independently from the structural frame of the building. This also incorporates for openable windows.

**2 Applicable Codes and Standards**

The specified reference standards are Codes which are intended to establish the quality of material and workmanship required for the works. More reference standards published in India and other countries may, in the sole judgment of the Owner's consultant, also be acceptable provided that the contractor furnishes sufficient data for the Owner's consultant to determine if the quality of materials and workmanship at least equals or exceeds the specified reference Codes.

The following is the list of codes included for guidance and compliance with applicable portions only and the omission of any from the list does not relieve the contractor from compliance therewith.

ASTM E 283 Air leakage through exterior windows, Curtain walls and Doors.

ASTM E 330 Structural performance of exterior window, Curtain walls and Doors under the influence of wind loads

ASTM E 331 Water penetrations of exterior windows, Curtain walls and Doors by uniform static air pressure differential.

**Note:**

1. Wherever a reference to any standard appears in this specification and as above it shall be taken as a reference to the latest version of the standard.
2. Contractor to ensure to keep all the above mentioned Codes at site for references.

**3 Submittals:**

The following submittals are required:

1. Final design construction documents
2. Documentation showing conformance with performance criteria.
3. Shop Drawing: The tenderer shall submit for approval of Owner/PMC including detailed shop drawings within 15 days of acceptance of tender giving full details such as size of sections, detail showing sill, jams and lintel end details with civil structure coupling members and method of fixing anchorage, caulking, flashing etc. The tenderer shall also give all mechanical properties of all sections (e.g. perimeters, area, moments of inertia about bending axes, principal axes, principal moments of inertia, weights etc.) in a tabular form.
4. Design Analysis and Calculations: Include design calculations for review of design loads and member profiles.
5. Samples:
6. Submit three samples of each required metal finish on 300mm (12 inch) long extrusion of the alloys to be used for the work. Where normal colour and texture variations are to be expected, include two or more units in each sample, to show
7. the range of such variation.
8. Submit three samples of glass, 300mm (12 inch) square
9. Provide two samples of typical fabricated sections showing joints, fastenings, quality of workmanship, hardware and necessary items before fabrication of the work proceeds.
10. Glazing materials: 300 mm (12 inch) long samples each colour and type required for glazing gaskets and sealant (Silicon/ polysulphide) with its catalogue. All samples to be provided at no cost to the Owner or Architect.
11. Statement that the system meets the regulatory requirement of all statutory authorities having jurisdiction over the works in respect of fire, thermal aesthetics, mirroring effect, wind, loading, construction and warranty requirement, nothing in detail any exceptions. The statement /under taking shall be signed by a person authorized to legally represent the company.

**4 Material:**

1. **Tempered/ Toughened Glass:**

Toughened/ Tempered glass shall be examined by the glass manufacturer to detect and discard any glass which exceeds the following tolerance: 1.5mm bow in 600mm: 3mm bow in 1500mm; 6mm bow in 3000mm; 9mm bow in 4500mm. Where the strengthening process results in essentially parallel ripples or waves, the deviation from flatness at any peak shall not exceed 0.13mm and the difference between adjacent peaks shall not exceed 0.13mm. Where bow tolerance and wave tolerance differ, the stricter requirements shall govern. Direction of ripples shall be consistent and in conformance with architectural design.

1. **Float Glass:**

Glass that gives distorted reflections will not be accepted. Reflections due to pressure, paints poor manufacturing process, uneven thickness or poor storage are some of the reasons for distortion. All clear float glass quality should conform to BS – 952 and ASTM C 1036 – 90.

1. **Scratches:**

Viewed from a distance of 3m, scratches not longer than 76mm shall be allowed only within 76 mm of an edge, or in an area of the glass through which a person normally would not be looking.

**5 Construction:**

1. **General:**

All fasteners into and through aluminium shall be non-magnetic stainless steel.

Free and noiseless movement of all components of the exterior wall system due to thermal effect, structural effect, wind pressure, erection or dead load shall be achieved without strain to glass without buckling of any component and without excessive stress to any members or assemblies.

Aluminium surfaces in contact with mortar, concrete, plaster, masonry, wet-application of the fire proofing and absorptive materials shall be coated with an antigalvanic, moisture-barrier material.

Contact between aluminium and dissimilar metals excluding non-magnetic stainless steel shall receive an isolation membrane for the prevention of electrolytic action and corrosion.

1. **Waterproofing:-**

A complete drainage system must be incorporated into the exterior wall frame. Water leakage and condensation shall be drained or discharged to exterior face of the wall, and all internal spaces shall be vented by acceptable means to ensure air-pressure equalization.

Drainage system shall be sealed off per floor height to prevent infiltrated water from leaking to lower floors.

Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapped water.

1. **Anchorage System and Building frame**

Each mullion will be fixed to the structural steel slab at each floor level. All steel fasteners supplied by the contractor will be galvanized to minimum 80-90 microns (as per IS codes 610gms/ Sqm). Any fasteners to be cast in concrete will be supplied and delivered to site & installed by the contractor. The contractor will co-ordinate with the main contractor to check the building frame and the exact pointing of fixing bolts or angles on site.

The contractor will also make necessary modifications to the anchor ties to suit different site conditions of steel reinforcement without additional charges.

1. **Mullions and Transoms:-**

The Sections of mullions and transoms shall be designed to withstand deflection and wind pressure as described in specifications and shall be rigid enough to support and retain the glass and spandrel under all conditions.

Reinforcing member, where used, shall be completely enclosed and if fabricated from steel shall be galvanized.

The frames shall be formed by approved Colour anodized (25 micron) in AC – 25 grade aluminium section with provision to receive fixed glass, construction variation as indicated.

Sections of the frame shall be cut and profiled for assembly in the best workmanlike manner and finished in a neat and weather-proof construction, with proper tempering of aluminium sections.

All dimensions of the Aluminium glazing shall conform to the overall sizes shown on the drawings. They shall be fabricated to proven and tested detail designs. All parts shall be supplied ready for fixing and complete with all necessary fittings. Samples of typical sections shall be submitted with the tender. The exact dimensions for frame work shall be physically checked at site before starting fabrication.

Before final fabrication is started the contractor will erect a mock-up which will include at least two fixed panels & at least one vent (window) and get same approved.

1. **Open able Sash and Ventilator:-**
2. Hardware for aluminium windows shall be designed to adequately perform the function for which it is intended and shall be securely attached to the window, and/or adjacent window. The hardware shall withstand the designed wind pressure both in open & closed window position.

The openable sash and ventilator when in closed portion will remain water tight under all weather conditions & passes the water tightness tests as specified.

1. Hinges shall be concealed stainless steel hardware. All hardware and accessories shall be supplied by the Aluminium work contractor, and when exposed, shall be of colour and finish to match members where possible. Numbers and strength of hardware shall comply with the wind load requirement.

Proposal on the complete set of hardware to be used shall be submitted along with the tender.

The detailed system of the openable sash and ventilator must be proposed by the tenderer as shown on the drawings.

**6 Lightning Protection**

The contractor shall provide the connectivity for Lighting Protection system in the curtain glazing as per the International Standard and shall also give the requirement of earth pits for the Lighting protection. The Aluminium Work contractor shall install all necessary conductors, wiring connection etc. for the curtain wall. The electrical contractor will be responsible for constructing the earthing system for the lowest point of the curtain wall to ground level.

Proposal on the lightning protection system shall be endorsed by a qualified lightning protection engineer. The whole of the system shall be tested to ensure its compliance with the requirements as laid down in the Indian Standard Code at the cost of the contractor.

**7 Mock-Up**

Prior to beginning production, furnish and install a sample each for a full size mock up. Production of any item shall not proceed until the mock up is approved. Mock up with shop drawings shall be submitted for review prior to manufacturing. Use materials, fabrication and installation methods identical with those required for the project.

**8 Design Responsibility and Performance Requirements**

Manufacturer shall be required to design systems to conform to design intent of profiles shown and design criteria specified, allowing for dead loads, wind pressures, thermal movements, earthquake, forces, erection loads and other conditions of usage which may reasonably be anticipated.

 **General:**

 The requirements shown by the details are intended to establish basic dimension of unit area modules and provide site line of members. The manufacturer shall be required to design the entire system, and to make whatever requirements as may be required to fulfil the performance requirements to maintain the visual design concept as shown, including member size and alignment of component.

 **Wind Pressure**

 Fabricate exterior windows, doors to withstand the wind pressure shown or if not shown 200 kg/sqm for straight portion and 225 Kg/Sqm for Curved portion including glass and other claddings for both positive and negative sides.

**Temperature Variation**

Thermal expansion and contraction movements resulting from an ambient temperature range of 2 to 50oc. which may cause a metal surface with temperature variation.

**Weather Resistance:**

Fabricate exterior units with weather stripping to prevent from uncontrolled penetration of air and water under normal shear weather conditions.

The manufacturer shall be responsible for methods and means of joining fabrication, assembly, suspension, erection and compliance with all design criteria.

**9 Quality Assurance**

**General**

The works shall conform to IS codes specifications for Aluminium glazing latest editions and in its absence the standards published in other countries.

 **Test units**

 It is required to perform all tests unless otherwise noted each portion of exterior wall system for both frame and glazing (fixed/ openable) to the satisfaction of Project Manager.

 **Tests**

 Following tests are to be performed as per relevant standards.

* Air infiltration test
* Water Penetration under Static Pressure
* Water Penetration under dynamic pressure
* Uniform load deflection test
* Uniform load structural test
* Testing anchor's to resist seismic stresses without damage of any kind
* Wind resistance test
* Anodising testing.

 Deflections shall be measured at the centre line members and at other critical points as deemed appropriate.

**10 Site Conditions:**

Manufacturer is to take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting of work. However, proceed with fabrication and coordination installation tolerances as necessary when field measurements might delay work.

**11 Product Handling, Transport, Storage and Protection:**

Protect units and finishes in manner that will not cause damage or discoloration to units by covering exposed surface with thick layer clear transparent lacquer or self-adhesive non- staining PVC tape before they are brought on site. The lacquer/ tape shall be removed on completion of erection/ wet Civil work after approval of Project Manager.

**12 Products**

**Materials:** All materials and finishes are to be new and free from defects which may impair the appearance, strength, function and durability of the exterior window system and related construction of the external coverings.

1. Aluminium: The aluminium-extruded sections shall conform IS designation HE/HV/9WP alloy with chemical composition and mechanical properties as per IS codes wall thicknesses to meet required loadings, with minimum for trim being 2.6mm. Test certificate for alloy and its extrusion from the manufacturer is required to be submitted by the contractor for its conformity. Recycled aluminium of approved make shall be used for IS codes and no extra shall be admissible on this account.
2. Coating/Anodizing: All aluminium sections shall be anodized or powder coated. Anodizing shall conform to IS codes and shall be of AC 25 grade with minimum thickness of 25 +/- 3 microns when measured as per IS codes and the density shall be at least 32mg/square inch. All sections are to be matt anodized in colour as per sample available with the architects. The anodic coating shall be properly scaled by steam or boiling in de-ionized water as per IS. In case of powder coating, factory applied electrostatic powder coated sections 60+/- 5 micron will be considered for approval. Colour consistency shall be accurate. Abrasion Resistance shall confirm to IS codes.

No visual variation in shade shall be permitted. The fabricator shall clearly indicate the shade variation tolerance as measured by standard equipment.

Structural and weather seal silicone sealant with Low VOC content of approved make duly approved is to be provided at shop and field joints which are sealed as part of assembly and installation procedures. It is to be applied appropriate for joint sizes, movement and substrate. Preshimmed tape shall be used against surfaces with grooves having backer rod at the groove of sufficient size and spacing to prevent shim migration.

Polysulphide sealant is to be applied between wall surface and door & window frames in clear shade with preshimmed tape to prevent shim migration.

1. Glass and glazing:

External glass shall be Double glazed unit as per specifications and details provided in Tender Document.

Glass thickness shown is minimum thickness and shall be as per requirement to withstand loads criteria and their performance.

For all the glasses in glazing works 'edge distance' is to be clearly ascertained and maintained.

1. Glazing Gaskets and Weather strips:

EPDM extruded gaskets of hardener 40+5 durometer shore A for sponge gaskets, 75+5 durometer shore A for hollow profiles and 60+5 for solid profiles having exception for flame propagation are to be used.

All interior corners of gaskets where compatible with procedures are to be vulcanized. Provide gaskets with continuous splines for positive engagements in splines pockets in frame members.

Gasket profiles are to be designed taking into cognizance the glass edge pressures and the required edge distance.

* Setting Blocks and Shims: Solid extruded EPDM with hardeners 85+5 durometer shore A, minimum length 100mm minimum width corresponding to glass thickness.
* Side Blocks: Solid extruded EPDM 55+5 shore A durometer block shall be of sufficient length to prevent point loading on glass.
* Hardware: To be as per approved samples. Design and fixing of hardware shall be got approved by the Architects. The joining accessories shall be such that they do not cause any bimetallic action and shall be free from visible defects. Visible screws to be anodized made up of stainless steel.
* Fasteners and anchor devices: Fasteners shall be concealed and as approved by Owner/PMC.

Mild steel supports sections of curtain walls should be hot dip galvanized and are to be separated by nylon or fiber gaskets, washers, sleeves and the like.

Fasteners used for bolting aluminium extrusions and their connecting members shall be aluminium or stainless steel. Fastener metals for joining various metal combinations shall be as follows:-

* Aluminium to aluminium- Use only aluminium or stainless steel
* Aluminium to stainless steel - Use only stainless steel
* Stainless steel to stainless steel - Use only stainless steel
* All exposed fastener materials are to be in stainless steel and anodised, except required otherwise.

The Contractor is required to submit test certificates to prove compatibility of any materials or components as required by the Architect/ Owner/PMC in charge without any additional cost for its conformance to the relevant standards.

**13 Fabrication**

 The details shown are based upon standard details by one or more manufacturers. Similar details by other approved manufacturer will be acceptable provided they comply with the size requirements.

**Shop Fabrication**

1. Aluminium glazing shall be fabricated from extruded aluminium member of alloys specified. Complete the cutting, fitting forming, drilling and grinding of all metal work prior to cleaning, finishing, treatment and application of coatings. Remove arises from cut edges and ease edges and corners to a reading of approx. 4mm.
2. Fabricate and shop assemble frame and sash members into complete window wall system as indicated along with anchors for support to the structure and with hair line joints where mechanical fasteners are used.
3. No bolts, screws or fastenings to impair independent movement.
4. Openable windows, typically, shall be fabricated to allow for inside glazing.
5. Miter all corners and mechanically stake over solid aluminium corner block, set and sealed in epoxy leaving hairline joinery and then seal weather tight.
6. Joinery methods must not discolor finish or be unsightly. Welding and brazing to comply with industry standards using system and rods for assembly and fabrication.
7. All frame corners and meeting rail intersection shall be made permanently leak proof.
8. Fasteners should be concealed except where otherwise shown, indicated or approved.
9. Provision for anchorage to the structure allowing for erection tolerances, thermal expansion and building deflections to make the unit vibration free with no visible or audible evidence of movement.
10. For glass to be fixed with minimum 'edge clearance' and 'bite' on glass, cutting is to be done precisely taking into consideration the recommendations by glass manufacturers, and design parameters along with performance requirement and gaskets and other practical considerations. Do not nip glass edges. Edges may be wheel cut or sawed and seamed at manufacturer's option. For glass to be cut at site, provide glass larger than required so as to obtain clean cut edges without the necessity of seaming or nipping Grind, polish, and ease arises, nip or abrade glass after heat tempering.
11. For weather stripping by EPDM extruded gaskets provision shall be made to insure that water will not accumulate and remain in contact with the perimeter areas of glass and securely staking and joining at corners.
12. All glass pockets, fixed and moving, shall be weeped to provide positive drainage. Water shall be weeped to the exterior via frame weep slots protected by snap-in weep covers integral drips.
13. Except as otherwise indicated provide each continuous unit of framework and all accessory items as a packaged unit. Complete the fabricated assembly, finishing and all other work to the greatest extent possible in the factory before brought to the project site. Disassemble only to the extent necessary for transportation and installation.
14. After fabrication all glazing units (including disassembled parts) shall carry their designation viz., W-1, G-2 etc., size and location to be fixed well identified through self-adhesive non-staining removable PVC tape.
15. Fire stopping: Preformed incombustible insulation with retaining devices to meet the building code requirements. Insulation shall be of required depth to maintain required floor to floor fire separation and of sufficient width to ensure that it fills all voids under compression.

**14 Execution**

**Inspection**

Examine all parts of supporting structure, the areas and conditions under which work comprising of glazing items, and associated items are to be executed. Identify conditions detrimental to the proper and timely completion of the work and proceed with the work after getting the unsatisfactory conditions corrected, if any.

**Co-Ordination**

Wherever possible, check actual opening in the construction work by accurate field measurements before fabrication and execution as well. Show recorded deviation if any, on final shop drawings and co-ordinate installation within fabrication tolerance to ensure proper fit of units/ modules.

**Preparation**

Co-ordinate setting drawings, diagram templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction.

Bench marks for elevations and building line-offset marks for alignment shall be established on each floor level by the contractor who shall be responsible for their accuracy. Should any error be found in their location the contractor so notify in writing and shall proceed in the affected areas after the errors have been corrected/ rectified.

Silicone sealant shall be applied all-round the junctions of window/ door frames and walls adjoining as per architectural drawings/ shop drawings and manufacturer instructions through an experienced applicator only.

**15 Installation**

The installation of fabricated frames shall commence when called for by the Owner/PMC. This shall be properly coordinated with the finishing works.

Installation of frame works shall be done under direction and supervision of manufacturer's representative.

All parts of the work shall be erected in plumb, level and true to line in proper alignment and in relation to established lines and grades and as shown on approved shop and or erection drawings without warp or rack of frames, sash or panels while positioning. Anchor securely in place. Separate corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

Do not install defective component parts including warped, bowed, dented, abraded and broken members or glass with edge damage. Remove and replace members/ unit which have been damaged prior to installation.

Do not cut, trim, weld or braze component parts during erection in any manner which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance. Return component parts which require alteration to the shop for re-fabrication or for replacement by new parts.

Install component parts in level, plumb and true to line with uniform joints and reveals. Secure to structure with no staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Use erection equipment which will not mar or stain finished surfaces or damage the component part in any way.

**16 Erection Tolerances**

Dimensional variation in the building frame and/ or work surrounding or surrounding the work are as determined in the field by field measurement of the work in place.

The work shall be designed to accommodate all tolerances and anticipated dead and live load movement, creep, sway and torsion of the structure without any harmful effects. All parts of the work, when completed shall be within the following tolerance:

* General: 3mm (1/8 inch) maximum deviation in any storey height or in any 3m (10 ft) vertical or angular run or in any 6m (20 ft) horizontal run.

6mm (1/4 inch) maximum deviation in any 12.2 m (40-ft) runs, any direction.

* Locational: 3mm (1/8") maximum change in deviation for any member for any 3m (10 ft) run, any direction.

9mm (3/8 inch) total maximum deviation for any member at any location.

* Offsets: Limit offsets in the end to end and edge to edge alignments of adjoining and consecutive members, which form planes, continuous runs and profiles to the following:

Slope or curvature shall not exceed 2% when measured at intervals of 25mm (1 inch) in any direction.

4mm (1/6 inch) maximum offset in flush alignments including alignments which are to be 13mm (1/2 inch) or less out of flush and alignments which separated 50mm (2 inch) or less by a reveal or protrusion in the plane of the wall.

3mm (1/8 inch) maximum offset in alignments which are out of flush by more than 13.0mm (1/2 inch) or separated by a reveal or protrusion in the plane of the wall.

Maximum offset from true alignment between two members abutting end-to-end, edge to edge in line or separated by less than 76mm, 0.8mm (shop and /or field joints 0< This limiting conditions shall prevail under both no load and full load conditions.

All aluminium frames shall be kept protected after installation by lacquer/ tape to avoid scratches by others.

**17 Sealant**

Sealing materials for sealing shall be structural or weather seal silicone sealant of approved make used in strict accordance with the manufacturer's printed instructions and shall be applied only by applicators/ mechanics specially trained or experienced in their use. Before applying sealant all dirt, dust, moisture and other foreign matter shall be completely removed from surfaces and shall be masked, when required, to maintain a clean and neat appearance. This shall provide a smooth finish surface.

**18 Anchorage**

Anchorage of the work to the structure shall be by approved methods in strict accordance with approved shop and/ or erection drawings. Supporting framework and brackets shall be so designed as to provide three dimensional adjustments and accurate location of all components. After the unit is properly positioned all connections so designated on approved shop drawings shall be rigidly fixed bywelding or other positive means.

Anchor component parts securely in place as shown by bolting, welding or other permanent mechanical attachment system which will comply with performance requirements and permit movements which are intended or necessary. Install slip joint lining wherever possible to ensure movement as in tended or necessary.

Wherever concealed contact surface or dissimilar materials before assembly or installation is existing or wherever there is the possibility of corrosive or electrolytic action, apply a suitable bituminous coating of approx. 0.76m (0.03 inch) dry film thickness or other suitable permanent separator.

**19 Setting**

Set all members and other members in a bed of compounder with joint fillers or gaskets to provide weather tight construction.

**20 Cleaning, Protection And Security**

 Clean debris, dust and other substances caused during erection and keep the scrap, if any, away from the site.

 The installed frames, sections and other components of aluminium glazing work in passages and exit(s) shall be kept protected and guarded for any damage by other working contractor's workmen.

**21 Glazing:**

**General:**

Before glazing, openings shall be checked to see that they are square, plumb and true plane. If found otherwise glazing shall not proceed until proper corrections are made. Inspect each piece of vision glass immediately before installation. Eliminate all which have edge damage or face imperfections.

 **Preparation**

Comply with recommendations and requirements of glass manufacturers for installation of all glass.

Clean glazing channels, stop and rabbets to receive glazing materials of obstructions and deleterious substances, which might impair the work.

Apply primer or sealer to joint surfaces wherever recommended by gasket manufacturer.

Clean with solvent all glass edges and faces which will be in contact with gaskets to remove all traces of cutting oils and other contaminates.

 **Setting Blocks and Spacers**

Locate setting blocks of proper size at sill one quarter in from each end of the glass unless otherwise recommended by the glass manufacturer. Set blocks in this course of the heel-bead compound, if recommended.

Provide spacers for all glass sizes larger than a combined total of 1.27m or more for any two adjacent sides to separate glass from stops, except where continuous glazing gaskets are provided. Locate spacers no further than 600mm apart and no closer than 300mm to a corner. Place spacers opposite one another. Make bite of spacer on glass a nominal 6mm or greater.

**Installation**

Glasses shall be installed and blocked in such a manner as to ensure proper glass bite on all sides. Correct glass sizes to insure glass bite shall be verified by measurement of the frames. Protect glass from edge damage at all times during handling installation and subsequent construction operation. Required glazing channel dimensions are to be provided as per glass size for necessary minimum 13mm bite on the glass, minimum edge clearance and adequate sealant thickness with reasonable tolerances.

Provide the correct glass size for each opening, within the tolerances and necessary dimensions by identified numbering from fabrication. Perimeter clearance must be sufficient to avoid all point loading. All structural silicone sealant to be applied by approved applicator of the manufacturer.

Provide watertight and airtight installation of each piece of glass so as to with stand temperature changes, wind forces and other effects as enumerated and specified.

## Structural Glazing

**1 General**

The complete structural glazing should contain at least 20% recycled content. The minimum VLT of structural glazing should be 25% as per green building requirements or as specified in design document or as per design requirements.

The Contract Documents define only the design intent and general performance requirements. The Contractor is entrusted with total responsibility for design, structural calculations, shop drawings, fabrications, installation, warranties, certifications and related documentation.

The Contractor shall be entirely responsible for the design, fabrication and erection of the systems, and all work shall be performed entirely by his own forces.

Design approved metal framing members to accommodate expansion and contraction of components without buckling, creating stress on glass, structural components and fasteners, joint seals or other damaging effects.

The Contractor shall provide to sealant manufacturer samples of all relevant substrates, including finished aluminum, coated glass, gaskets, setting blocks and brackets.

Sealant manufacturer shall perform tests to verify adhesion, staining and chemical compatibility. The Contractor shall use sealants and substrates only in combinations for which favorable addition and compatibility results have been obtained.

Aluminum surfaces in contact with mortar, concrete, plaster, masonry, wet application of the fire proofing and absorptive materials shall be coated with an anti-galvanic, moisture barrier material.

**2 Samples**

Sample of one typical panel shall be fabricated, assembled and installed for approval. It shall be of type as per approved drawings. All samples shall be provided at no cost to the Owner.

**3 Design Considerations:**

The Contractor should possess adequate engineering background and facilities inclusive of trained system personnel from their parent company and should be able to prove their design and engineering capabilities to meet structural design parameters.

The Contractor shall submit structural calculations for the system and it shall be stamped and signed by a qualified structural engineer, including mock-up complying with current design rules of the relevant aluminum code include analysis for wind, dead loads, deflections and if appropriate seismic loads on framing members and anchors. All Curtain glazing shall have mechanical joints shall be designed to withstand a wind load of 200 kgs per sqm or as per Indian standard codes whichever is more. The design shall also ensure that the maximum deflection of any member shall not exceed 1/175 of the span between supports or 20mm, whichever is less for vertical elements & 1/250 of the span between supports for horizontal elements. Air leakage through windows should not exceed 0.60 Cu.ft/Sq.ft. Minimum design pressures both inward, outward and acting perpendicular to glass (including return surfaces) shall be per the requirements the Wind Loading as Indian standard codes and earthquake regulations.

The framing members should be designed such that deflection perpendicular to the wall plane of any unsupported span shall not exceed 1/175 or 20mm whichever is the least, under the required design load both positive and negative. Also no failure of structural silicone Jolts, damage to joinery, components, or permanent set in the framing members in excess of 0.2 percent of the span shall occur under 1.5 times the design load. Deflection in the wall plane of any glazed horizontal span should not exceed ½ the glass edge clearance dimension below.

The Contractor shall also submit the calculations for the structural silicone joint, size as required.

**4 Water Tightness**

A complete drainage system must be incorporated into the curtain wall frame. Water leakage and condensation shall be drained or discharged to exterior face of the wall and all internal spaces shall be vented by acceptable means to ensure air-pressure equalization when possible.

Drainage system shall be sealed off per floor height to prevent infiltrated water from leaking to lower floors.

Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapped water.

**5 Shop Drawings**

The Contractor shall prepare detailed shop drawings incorporating all allowances for construction and fabrication tolerances.

The Contractor shall submit detailed shop drawings for all components of glazing works.

The Employer’s review will be conformance to the design concept and for the general arrangement only. And such review shall not relieve the Contractor of any responsibilities as stated herein or any other applicable items herein specified.

The Shop drawings shall show joinery techniques, provisions for horizontal and vertical expansion, glass and metal thickness, framing and anchor member profiles, identification all materials including metal alloys, glass types, fasteners and glazing materials, all shop and field sealants by product name. This shall also show relative layout of all adjacent walls, beams, columns and slabs with all dimensions to each other and grid lines/ dimension position of glass edge relative to metal daylight, anchorage details to the building structure and coping details at the parapet are also to be submitted. The drawing shall also indicate all gaskets, weather strips and Aluminum extrusions and fire seals.

Shop Drawings shall be signed and sealed by a Qualified Structural Engineer with specific experience in Curtain Wall construction and design.

**6 Samples:**

The Contractor to submit samples for review three (3) sets of labeled samples of each required type and colour of metal finish, on 300mm long sections of aluminum extrusion shapes. Samples must show extremes of colour texture variation. Samples will be reviewed by Owner/PMC for colour and texture only. Compliance with other requirements is the responsibility of the Contractor. Colour and texture range of production material shall match approved samples.

Owner/PMC reserves the right to require samples which will show the fabrication techniques and workmanship of the component parts, and the design of accessories and other exposed auxiliary items, before fabrication of this work proceeds.

**7 Aluminium**

Extruded aluminum sections should conform to Indian Standards designation HE9WP/HV9WP, the chemical composition requirements of Indian standard codes, and technical properties as laid down in Indian standard codes. Standard commercial tolerances shall apply to finished, fabricated and assembled materials.

* **Mullions and Transoms**

The sections of mullions and transoms shall be designed to withstand deflection and wind pressure as described in specifications and shall be rigid enough to support and retain the glass and other construction variation as indicated.

Reinforcing member, where used, shall be completely enclosed and if fabricated from steel shall be galvanized and protected with two coats of zinc chromate where welded shall be treated in the same way.

The frames shall be formed by integrated colour anodized aluminum section with provision to receive fixed glass spandrel and other construction variation as indicated.

Sections of the frame shall be cut and profiled for assembly in the best workmanlike manner and finished in a neat and weatherproof construction with proper tempering of aluminum sections.

All dimensions of the curtain wall shall conform to the overall sizes shown on the drawings. They shall be fabricated to proven and tested detail designs. All parts shall be supplied ready for fixing and complete with all necessary fittings. Samples of typical sections shall be submitted with the tender. The exact dimensions for frame work shall be physically checked at site before starting fabrication.

All jolts shall be mechanical, jolted with aluminum angles with stainless steel screws.

**8 Silicone Sealant:**

The Contractor shall send a sample of anodized/ powder coated aluminum section & reflective glass to the silicon sealant manufacturer and get his approval. A copy of that certificate to be submitted to Owner/PMC . The cost of samples, carriage of the samples and testing charges, if any shall be borne by the Contractor.

The Contractor shall submit, for record only, glass manufacturer’s written statement that any insulated glass, reflective glass and spandrel glass is supported by structural silicone is suitable for such application.

The colour/ shade of sealant shall be decided by the Owner/PMC and the Contractor to get approval before procurement.

**9 Glass Specification:**

Glass specification shall be as per Design parameters specified in Part -B / Section-11/ Volume-III of the tender document.

**10 Accessories:**

Extruded gaskets, weather stripping, extruded seals and spacers, which do not come into contact with structural silicone sealant shall be of Ethylene Propylene Diene Monomer (EPDM) or approved equivalent. Where in parallel contact with structural silicone sealants, all gaskets, setting blocks and spacers other than foam glazing tapes shall be of heat cur silicone rubber, chemically compatible with the silicone sealant and suitable for the specific purpose intended. All extruded gaskets, weather stripping and spacers other than foam glazing tapes shall have continuous mechanical engagement to framing members adhesive attachment is not acceptable.

The cladding system shall be constructed with (and shall maintain during its design life) a standard of seal which shall not result in any reduction of sound insulation performance.

Gaskets, weather stripping and fire seals used to achieve the required waterproofness and/ or air tightness shall be selected to accommodate fully the range of dimensional tolerances associated with fabrication and installation of the cladding system. Gaskets, weather stripping and seals shall be formed from materials capable of retaining their elastic qualities, dimensions and resistance to physical and chemical attack sufficient to maintain the full water tightness, air tightness and acoustic performance for the design life of the curtain wall.

Extruded gaskets, weather stripping, fire seals and spacers mechanically engaged by flutes or pockets extruded in framing member shall be installed without residual tension or extension. Dry lubricants may be used to reduce drag during installation of synthetic rubber extrusions and to induce compression so as to prevent gradual elastic shrinkage and retraction from their ends. Wet lubricants containing detergent shall not be used for any purpose which may bring the liquid into contact with the coated surfaces of vision and spandrel glass.

**11 Fabrication & Installation**

Installation shall be in true line vertically and horizontally.

Work shall be done by competent workmen who are thoroughly skilled in their trade. Assemblies shall be neat and free of defects that impair strength, function or appearance. The work shall be accomplished in compliance with the specified criteria without buckling opening or joints. Under stress on fasteners, sealants and gaskets, opening of welds cracking of glass leakage noises and other harmful effects.

As far as practicable fitting and assembly of the work shall be done in the shop.

All exposed work shall be carefully matched to produce continuity of line and design. All joints in exposed metal work, unless otherwise shown or specified shall be accurately fitted end rigidly secured with joint sizes conforming to industry standards.

Except where otherwise shown specified or directed the method of assembly and joining shall be as per approved shop drawings. Fabricate and fasten metal work so that the work will not be distorted nor the fasteners over stressed from the expansion and contraction of the metal.

All welding shall be in accordance with the appropriate recommendations of the Indian standard codes and shall be done with electrodes and/ or by methods recommended by the manufacturer of the alloys being welded. All welds behind finished surfaces shall be done as to minimize distortion and/ or dis-coloration on the finished side. All weld spatter and welding oxides on finished surfaces shall be removed by de-scaling and/ or grinding.

Unless otherwise shown or specified, all weld beads or exposed surfaces shall be ground and finished to match and blend with finish on adjacent parent metal. Grinding and polishing of nonferrous metal shall be done only with clean wheels and compounds free from iron and iron compounds. No soldering and/ or brazing shall be allowed.

The Contractor shall conceal all the fasteners where visible in the finished work.

All aluminum components shall fabricate before finishing, Cutting of components will not be acceptable.

As the building is exposed to varying weather actions, all fasteners shall be stainless steel, self-tapping screws with Aluminum brackets. Steel anchors shall be pre-holed and galvanized. The bolts shall be steel chromium plated along with nuts and covered with butyl sealing compound.

Where aluminum comes into contact with masonry, brickwork, concrete, plaster or dissimilar metals, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electro-chemical corrosion is avoided.

The Contractors shall be responsible for placing in position the curtain wall frames for the satisfactory performance and should be totally leak proof for a minimum period of ten years

**12 Sealant And Gasket Application**

Sealant and gasket shall be provided wherever shown in the drawings or required for a permanently weather tight installation. The sealing mechanism for each location and use shall be as indicated on drawings in those locations where a mechanism is necessary but is not indicated. It shall be of type recommended by the Contractor and approved by the Owner/PMC .

All adjoining surfaces shall be protected to receive sealants against staining by masking and/ or other methods.

Joints and joint surfaces shall be clean, dry and free of any material that may have an adverse effect on the bonding and/ or seal of the sealant and gasket materials.

Apply sealants and gasket under the conditions recommended by the manufacturer(s) Prime all surface to receive sealants and gasket unless recommended otherwise use no sealant that has started to set in its container or a sealant that has exceeded the self-life published by the manufacturer.

Fill all joints continuously and completely with sealant forming a neat uniform concave bead. Finish the material flush with adjoining surfaces unless otherwise shown on the drawings. All sealant surfaces shall be tooled smooth.

**13 Certification:**

The Contractor shall submit a letter of certification from the sealant manufacturer stating that the sealant has been tested for adhesion and compatibility on production samples of metals, glass, and other glazing components, and that all sealant details and application procedures shown on the reviewed shop Drawings are acceptable for use.

Where the curtain wall and other cladding impinges on, intercepts, covers, is attached to or supported by the work of other trades, for instance at parapet-level junctions with roof membranes and back-up walls, the Contractor’s shop drawing and location drawings shall clearly distinguish elements and components of construction by other.

**14 Anchorage System And Building Frame**

Each mullion shall be fixed to the structural slab at each floor level. All steel fasteners shall be galvanized to minimum 80-90 microns coated with zinc chromate primer and supplied by the Contractor.

**15 Water Tightness**

No gross leakage shall be observed when subject to test for water penetration as described in Indian Standard codes as applicable. .

**16 Method Statement For Hose Testing At Site:**

**Test Area:**

Area (s) to be tested will be selected by the Owner/PMC in accordance with the standard. The total area will be not more than that can be tested in one day. Testing shall be done at least one area of 100 square feet, in accordance with the test standard, or more, depending on the time, and availability of suitable access to the exterior. In case of failure the prescribed procedure for a reasonable time but not more than that can be completed on the same day shall be followed. The test will be supervised via two-way radio from the inside.

**Equipment: Requirements**

* (Optional) washing of the area
* Visual checking of test area for snags, visible defects etc.
* A cradle or scaffolding on the exterior at the locations (s) of the test specimen (s) with an operator, a person to stabilise the cradle, a person to hold and point the nozzle, technical person to communicate between the people on the exterior and test engineer.
* Clean water in a minimum ¾” supply hose with approximately 4 bar pressure. Note that the pressure given for the test is with the water flowing, much higher actual pressure is necessary. Water pressure drops 1 bar for every 10m rise in height.
* Drying of test area and application and removal of tape if necessary to locate leaks.

**Test Criteria:**

Water will be sprayed at a pressure of 30 –35 psi (2.07-2.41 Bar) in accordance with the test standard. The flow rate will not be monitored.

The nozzle will be held 30 cm. from the wall spraying 1.5m lengths back and forth along each joint, successively, for five minutes each, working from the bottom up. Joints are interfaces between materials, and where these are less than 120mm apart are to be considered one joint.

**Test Procedure**

The initial area shall be the width of the cradle. The lowest horizontal joint will be wetted first, covering each 1.5m length in five minutes.

Next the cradle will be positioned so that the first 1.5m above the bottom horizontal joint can be reached and each vertical will be sprayed in turn over a period of 5 minutes.

The cradle will then be raised to test the next 1.5m and then the next horizontal and so on.

**Leakage**

If there is any leakage the test will be stopped and the procedure described in the Standard will be followed up to the time allowed.

A compliance report suggesting any modification/corrective steps to be taken if any leakage was observed.

**17 Field Check Of Glazing Systems For Water Leakage**

**Scope and Purpose**

This field check is intended to determine the resistance to water leakage of only those joints, gaskets and sealant details in the glazing which are designed to remain permanently closed and watertight. If operable joints such as those around doors and operable windows occur within the glazing area involved, appropriate modifications both of procedure and performance requirements should be made when testing such joints or details.

  **Preparation of Wall**

All wall framing and/ or wall units shall be installed on the lower two typical floors of the building for curtain wall resting and on the lowest typical floor for storefront testing. The area shall be compressed at least 75 lineal feet and shall be fully glazed to provide a complete wall installation. All of this work shall be done in strict accord with approved shop drawings and job specifications. The architect will then designate an area of the completed wall to be tested. The test area shall be a representative sample of typical construction and shall have no outstanding punch list items or other visible defect. If no test area and/ or location have been identified, an area should be selected by the persons doing the test. This area should be selected to provide representative performance data, usually a minimum of 100 square feet. The area to be tested should include, perimeter caulking, typical splices, frame intersections, and, if applicable at least 2 entire intermediate vertical member and an intermediate horizontal member.

**Apparatus**

The test shall be conducted using a Type B-25, # 6.30 brass nozzle with a ½” FPT as manufactured by Monarch Manufacturing Works., Inc. The nozzle shall be used with a ¾” diameter hose and shall be provided with a control valve and a pressure gauge between the valve and the nozzle. The water pressure to the nozzle shall be adjusted to produce 30 to 35 psi at the nozzle inlet.

**Procedure**

The water shall be directed at the test section and perpendicular to the face of the wall. The nozzle shall be moved slowly back and forth above approximately five (5) linear feet of the framing and joints, at a distance of 1 foot (305mm) from the most exterior surface of the wall for a period of five (5) minutes.

Working from the exterior, the wall test section shall be selectively wetted progressing from the lowest horizontal framing member, then the adjacent framing Intersections, then the adjacent vertical framing members, etc. during the test, an observer on the Indoor side of the wall, using a flashlight if necessary, shall check for any leakage and shall note where it occurs.

If no leakage occurs during the five minute test, the next five feet of framing shall be wetted for five minutes, and testing continued in this manner until the entire test area is tested.

If water leakage occurs and the source of the leakage cannot be identified, the following sequence shall be followed.

After allowing the wall to dry completely and working downward from to top of the area to be checked, all joints, gaskets and framing within this area shall be completely and tightly covered, on the outdoor side, with a water proof adhesive masking tape if necessary, use small amounts of sealant where the tape wraps around framing corners and joints to ensure that the masking is complete and waterproof.

Starting at the bottom of the prepared area, the masking tape shall be removed from the lowest horizontal framing for a distance of not more than 5 feet (1524 mm) from one end of the frame, including the joint Intersection or corner at that end. This exposed length shall be subjected to the nozzle spray as directed in Section 1.7.5 (a)

If no leakage occurs during the five minute test period, this length of framing shall be considered satisfactory and shall remain uncovered. If leakage has occurred at any point, the framing shall be re-taped at such points to prevent further leakage of these points during the subsequent checking of joints and framing adjacent to or above them.

This process shall then be repeated on all framing, gaskets and joint Intersections within the designated area, using increments of exposed framing length not exceeding five feet (1524mm) and always working upward on the wall.

Note : In some cases, due to unforeseen delays or other causes, more than one working day may be required to completely check the designated area, necessitating that some or all of the masking tape be left in place over night. The tape should not remain on finished metal surfaces any longer than necessary, especially where subjected to strong sunlight, as this may make its removal difficult and may also cause staining. It is recommended that in no case should the tape be left in place more than 48 hours.

Remedial Work and Re-Checking

Wherever leakage has occurred, the framing shall be made watertight in a manner acceptable to the architect. Remedial work involving the use of curing-type compounds shall be allowed to set before it is re-checked for leakage.

After all necessary remedial work has been completed, the required curing time, if any, has elapsed, all repaired framing sections shall again be checked, following the same procedure as before (Section 4). Should leakage still be found, further remedial measures shall be taken and checking shall be repeated until all framing in the designated area is found to be satisfactory.

Note: For these specifications, water leakage is defined as any uncontrolled water that appears on any normally exposed Interior surfaces, that is not contained or drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water contained within drained flashings, gutters and sills is not considered water leakage. The collection of up to one half ounce of water (15 ml) in a five minute test period on top of an interior stop of stool integral with the system shall not be considered water leakage.

**18 Cleaning And Protection**

Glass shall be protected from breakage immediately upon installation. Use streamers or ribbons suitably attached to framing and held free of the glass. Do not apply warning marking directly to the glass.

Protect glass and glazing materials during the construction period so that they will be without any indication of damage at the time of acceptance. Cover glass as required to protect it from abrasion and other activities that might abrade the surfaces.

Remove and replace glass which is broken, cracked, chipped or damaged in any way and from any source.

All debris caused by or incidental to the installation work shall be properly removed from the job site as the work progresses.

Wash glass on both faces (inside and outside) not more than 4 days prior to acceptance. Comply with instruction and recommendations of the glass manufacturer and glazing material for cleaning in each case. Remove manufacturer protective covering from frames when directed.

**19 Warranty**

Immediately on completion of the work contractor shall submit a warranty for all glazing work done by him against manufacturing defects, malfunctioning or under capacity functioning.

The warrantee shall be valid for a period of Ten years from the date of virtual completion of the work.

The warrantee shall relate to materials and its installation work within limits of specified tolerances for vibrations, wind whistles, colour, gloss and other performance levels.

The warranty shall include replacement of sealant and glazing materials which breakdown in any form, lose adhesion to the glass or metal framing. The contractor shall rectify and allow for all costs associated with making good, any defect or breakage during this period for the system.

The warrantee shall expressly include replacement and making good of all defective or under-rated capacity/ efficiency parts as acceptable in the contract.

**20 Insulation**

XPS (Extruded Polystyrene) Insulation shall be used on exterior walls and exposed roofs. For walls, 60 mm XPS insulation with 32 kg/ cum density and K value 0.028 W/m-K and Resistance of 2.14286 sqm K/W to be used. For podium, exposed roofs etc. XPS insulation 100mm thick with 32kg/ cum density and K value 0.028 W/m-K and Resistance of 3.571 sqm K/W to be used.

XPS shall be of approved make and installed as per manufacturer’s specification.

## GRC JALI:

Decorative Glass Reinforced Concrete Jalis in Parapets/ Railings/ Shafts/ facades etc in approved design/ colour/ pattern of approved make, 12-15 mm thickness, weight 25-40 kg/ sqm, dry density 1.8 - 2.2 T per cum in acid wash (stone finish) with Glass fibre (AR) between 2.5 - 5%, flexural strength 6 - 11 Mpa, Compressive strength 35- 65 Mpa and Impact Strength 7-20 KJ/sqm complete as specified and as per directions of the Owner/PMC in charge.

## Acoustic Partitions

Providing and fixing 75mm thick partition which includes one layer of tapered edge 12.5mm thick Gypsum board (conforming to IS codes) screw fixed with drywall screw of 25mm at 300MM centers to either side of 48mm studs (0.55mm thick having one flange of 34mm and another flange of 36mm made of GI steel) placed at 610mm center to center in 50mm floor and ceiling channel (0.55mm thick having equal flanges of 32mm made of GI steel) with joints staggered to avoid through joints. Finally square and tapered edges of the boards are to be jointed and compound, paper tape and two coats of Gypsum board top coat suitable for Gypsum board.

The partition system shall be provided and fixed as per approved drawing and specifications. It shall have insulating material for best desired acoustical values and raceways for wire management with outlets for convenient access to automation facilities as per the approved drawings and specification.

## Stainless Steel Tubes and Plates

Stainless steel tubes & plates shall comply standard of Grade 316 / 304 as per specifications conforming to American Iron & Steel Institute. It should contain Nickel @ 8 to 10.50% and Chromium @ 18 to 20%. It should be non-magnetic type with minimum wall thickness of 1.50mm or as specified in the drawing. The fixing of railing pipe with vertical SS pipe & SS plate shall be carried out by welding with special electrodes used for stainless steel welding. SS plate shall be fixed to the concrete with the help of wedge bolts.

Scope of Work -The work shall include providing and fixing of handrail and other things necessary to complete the work as specified and shown in the drawings complete in all respect to give the quality of finished work as desired by and to the entire satisfaction of the Owner/PMC.

Approvals-The sample of the material shall be submitted to the Owner/PMC for approval before fabrication of the work.

Material- Handrail, railing, Q partition and any other stainless steel work, shall be made of welded cold drawn solution annealed and pickled; stainless steel tubes grade 304 as per ASTM-A 249-95a.

 Outer diameter of the tube will be as specified and shown in the drawing. Thickness of wall shall be 2mm. Finish of the tubes will be matt/buff as specified.

 Outer diameter of the tube will be as specified and shown in the drawing. Thickness of wall shall be 2mm. Finish of the tubes will be matt/buff as specified.

Installation- G.I. sleeve of 40mm dia will be grouted in the steps / landing of staircases or railing as specified and shown in the drawing. Stainless steel baluster will be bolted to the sleeve and lead jointed. Wherever required, ends of the handrail tube to be capped. Assembly is to be true in line and upright as per requirement.

 Work shall include providing and fixing stainless steel works as specified and required as per relevant drawing. The whole work shall be finished absolutely clean, true in line and lengths and in workman like manner. Approval for specific items shall be obtained in advance from the Owner/PMC.

 Installation will be done to suit the site conditions and as shown in the drawings. All necessary screws, nuts, bolts, welding, threading, chasing, cutting, supporting and making them good shall be done as required.

## Modular Toilet Cubicles

This item shall be executed as per manufacturer specifications. Shop drawings shall be submitted and samples to be got approved before going for execution by the vendor.

1 Green Guard Certified Restroom Cubicle With (Standard Dimension Of 2100mm Height X 900mm Width x 1550mm Depth, which includes 600mm door size width).

Restroom Cubicle with (standard dimension of 2100mm Height x 1300mm Width x 1995mm Depth, which includes 750mm door size width). –as per dwg – to be finalised

2. Compact Laminate:

12mm compact laminate made as per IS codes and as per fire retardant bs-476/97 standard. The solid compact laminate (phenolic core board) is based on thermostatic resin, homogeneously reinforced with cellulose fiber and laminate on both side with suede finish, scratch and impact resistant, to achieve the cubicles dimensions joint-less partitions. The cubicle system will be equipped with heat and bacteria resistance, to supply and install restroom system complete with stainless steel accessories, the modular shall possess 100% resistant properties towards: water, chemical, impact.

3. Accessories:

Standard make stainless steel grade 304 with satin finish accessories (a) ss top rail, (b) coat hook with door stopper, (c) hinges – gravity to close, (d) privacy thumb turn c/w occupancy indicator, (e) door knob, (f) screws & wall plugs, (g) ss “u” channel & (h) adjustable pedestal.

4 Hardware & Fixing:

All screws will of 304 Grade in stainless steel with satin finish. All pilasters are supported by stainless steel Bottom Cladding. The base of the stainless steel bottom cladding will be anchored to the floor with a clearance height upto 150mm. Fixing of intermediate panels to the wall shall be stainless steel ‘L’ – Bracket or stainless U-Channel section are fixed into wall with screw inserts.