

1. SURFACE EXCAVATION

1.1. Scope of Work

- i) The specifications described herein cover the surface excavation in and around structures, foundations, etc. all other facilities & similar works and shall include all labour, materials, plant, and equipment necessary to carry out the excavation in all materials, the transportation and stockpiling or disposal of all excavated materials into stockpiles or disposal areas including all leads and lifts as shown on the drawings or as approved by the Engineer-in-Charge.
- ii) Excavation shall be made to the lines, grades and dimensions shown on the drawings or as otherwise directed by the Engineer-in-Charge.
- iii) The Contractor shall maintain the excavations as per the drawings or as required by the Engineer-in-Charge.
- iv) Where, in the opinion of the Engineer-in-Charge, clearing is necessary, the area of surface excavation shall be cleared of all trees, bushes, rubbish and other matter and the materials removed shall be burnt or otherwise disposed off as directed by the Engineer-in-Charge.
- v) When the contractor for his own convenience requires additional excavation outside the lines and grades shown on the drawings, such additional excavation shall be required to be backfilled with acceptable material and compacted by the contractor in a manner satisfactory to the Engineer-in-Charge. The Contractor shall submit his plans for such proposed work in writing for Engineer-in-Charge's acceptance prior to the commencement of the Work.
- vi) When necessary, or when requested by the Engineer-in-Charge, the Contractor shall remove mud and slush resulting from heavy rains or flooding of the sites in order to ensure the safe and effective performance of the Work.
- vii) At all times during construction, the Contractor shall adopt excavation procedures such that at no time shall the stability of any slope be impaired.
- viii) The approval given by the Engineer-in-Charge to the Contractor's methods and equipment shall not relieve the Contractor of his full responsibility for a proper and safe execution of excavations, or of liability for injuries to, or death of persons, or any obligations under this Contract.

- ix) The Contractor shall comply with all safety procedures and requirements as stipulated in relevant IS Codes and Standards.
- x) Seepage water from springs or rainwater shall be suitably collected and drained away by gravity, wherever it is possible to do so. However, pumping could be resorted to where drainage by gravity is not possible.
- xi) The Contractor shall install an adequate illumination system on the work sites in order to suffice the ongoing works.

1.2. Methodology of Surface Excavation

1.2.1 Clearing

- i) Clearing shall consist of cutting and disposing of all trees, stumps, roots, rubbish, bushes, any other vegetation and existing structures, foundations of structures, fences or any other objectionable materials.
- ii) All flammable material resulting from clearing shall be disposed off by the Contractor in a manner acceptable to the Engineer-in Charge. None of the disposed material shall be piled in stream of river or in a location.

1.2.2 Excavation

- i) This methodology includes removal of all over-burden dry or wet restricted to materials such as silt, earth, clay, sand, gravel, soft morum, soft and disintegrated rock which can be removed manually or by earth moving equipment. This shall also include removal of all material wet or dry deposited during the monsoon over the portion excavated prior to monsoon.
- ii) Stripping consists of removing all or part of the organic topsoil in the areas and to the depth as indicated on the Construction Drawings or as directed by the Engineer-in-Charge.
- iii) Loose excavation means general excavation of material such as organic topsoil, clay, silt, sand, gravel, and boulders and soft or disintegrated rock, which can be removed manually or by earth moving equipment.
- iv) Stripping and loose excavation shall be accomplished by proper excavation and hauling equipment suitable for the work which allows for an efficient work progress adopted to the soil conditions encountered.

- v) Silt/Slush deposit; if any during the course of construction shall have to be removed and properly deposited by the contractor.

1.2.3 Excavation for Foundations of Structures

- i) While carrying out excavation for the foundations of the structures, if it is considered necessary for the particular Work, and if approved by the Engineer-in-Charge, the sides of the loose excavation shall be shored and strutted to the satisfaction of the Engineer-in-Charge.
- ii) After completion of the loose excavation, the rock excavation in foundations of structures shall be carried out to the depths as shown on the drawings. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines of required excavation.

1.2.4 Chiselling and Benching

Chiselling and Benching shall not ordinarily be resorted to for roughening foundations. In case at some specified locations chiselling and benching is specially required by the Engineer-in-Charge, it shall be carried out as per the Engineer-in-Charge's directions.

1.2.5 Excavation Clean Up and Preparation of Foundations

- i) After completion of excavation of foundations, trimming and final removal of all loosened rock and soil, shall be carried out by chiselling, barring and wedging, as directed by the Engineer-in-Charge.
- ii) Any weathered or decomposed rock remaining shall be removed.

1.2.6 Disposal of Excavated Materials

- i) All materials from surface excavation suitable for use as concrete aggregates or for other purposes shall be stockpiled on the Site at designated places, as directed or approved by the Engineer-in-Charge.
- ii) The Contractor shall shape and trim the disposal areas and stockpiles to the lines and grades as directed or approved by the Engineer-in-Charge, and shall provide for adequate diversion of existing water courses. The area over which the excavated material is to be disposed shall be stripped of all vegetation and topsoil and the topsoil shall be stockpiled nearby separately. If the area is steeply dipping, precautions shall be taken to ensure stability of the material in the area, including base drainage and surface protection against

erosion. It shall be the responsibility of the Contractor to remove any material from any slide that may occur in the disposal dump or its base and re-dispose the removed material properly. Prior to the commencement of excavation Work, the Contractor shall have prepared the disposal area with adequate slope protection work by constructing sausage wall etc. and the methods proposed for disposal shall also have received approval of the Engineer-in-Charge.

- iii) The Contractor shall be liable for any damage to Temporary or Permanent Works or to the property of third parties caused by poor drainage or poor dumping in the waste disposal or stockpile areas.
- iv) If additional areas are required for disposal of the excavated materials, the Contractor shall propose such areas for approval of the Engineer-in-Charge.
- v) The Contractor shall ensure that no excavated materials are disposed off in the streams or at locations where in the opinion of the Engineer-in-Charge, these are liable to be washed away by the floods.
- vi) On completion of the disposal or removal of the stockpiles, the contractor shall put back the topsoil that kept separately and seed the area with an approved grass mixture.

2. CAST IN SITU CONCRETE

2.1. Scope of Work

- i) This section of the specification deals with plain & reinforced cement concrete for general use and in structures and covers the requirements for concrete, all labour, materials, their properties, storage, handling, grading, pouring, casting, curing, finishing, formwork, scaffolding, etc.
- ii) The concrete Work shall be performed to the dimensions as shown on the drawings or as otherwise directed by the Engineer-in-Charge.

2.2. General Requirement

- i) The provision of IS: 456 shall be followed as general guidance, along with all other relevant Indian Standards, unless otherwise specifically mentioned.
- ii) Before starting a concrete pour, the Contractor shall obtain the approval of the Engineer-in-Charge.

2.3. Materials

2.3.1. Cement

- i) In general, all the materials used in the concrete shall be in accordance with the Technical Specification for Properties, Storage and Handling of Common Building Materials, as per IS: 4082.
- ii) The Engineer-in-Charge shall have the right to inspect the source of materials, method of procurement and storage of materials, quality control procedures, etc.
- iii) The cement used shall be the Ordinary Portland Cement conforming to IS: 8112 or Portland Pozzolana Cement conforming to IS: 1489 or Portland Slag Cement conforming to IS: 455 or any other type of cement specified in IS: 456 with the prior approval of the Engineer-in-Charge.
- iv) However, any special type of cement such as High strength cement or sulphate resisting cement may be used under special circumstances on approval of Engineer in charge.

2.3.2. Aggregates

i) General

- a. Unless otherwise specified concrete aggregates shall conform to the requirements of IS: 456 and IS: 383.
- b. The quality of all aggregates used in the work, including processing such as washing, classifying, screening, re-screening, crushing and blending, necessary to meet the required specifications, shall all be subject to acceptance of the Engineer-in-Charge.

ii) Fine Aggregates

- a. Sand shall be used as fine aggregates for concreting work,
- b. It shall be either natural river sand or manufactured, sand crushed from rock/ stones or mixture of both in specified proportions. The sand shall be hard, clean and gritty and of a quality approved by the Engineer-in-Charge. It shall be free from injurious amount of clay, soft and flaky particles, vegetable or organic matter, loam, mica & other deleterious substances and shall not contain any salts,

- c. The fine aggregates shall conform to the requirements of IS: 383. Varying amount of moisture in fine aggregates contributes to lack of uniformity in concrete consistency. The fine aggregates shall therefore have uniform and stable moisture contents. Dry sand shall be preferred. Hence, sand stockpiles shall be protected from rainfall,
- d. The sand shall be well graded.
- e. Maximum amount of material finer than 75 micron shall not exceed 1% by weight,

iii)

Coarse Aggregates

- a. Coarse aggregate shall consist of screened natural gravel or crushed rock and shall conform to the requirements of IS: 383,
- b. The term coarse aggregate is used to designate aggregate that is reasonably well graded and ranging in size of particles from 4.75 mm to 150 mm or any size or range of sizes within such limits. The coarse aggregate shall conform to relevant specifications of IS: 515 (for natural and all manufactured aggregate), or IS: 383 (for natural aggregate as revised from time to time),
- c. Natural coarse aggregates shall consist of uncoated hard, strong, dense and durable pieces and shall be free from injurious amounts of disintegrated stones, soft flaky or elongated particles, salt, alkali, vegetable matter and other deleterious substances,
- d. Coarse aggregate shall be hard, dense, durable, uncoated rock fragments. Rock having an absorption greater than 3% or specific gravity less than 2.5 shall not be used.
- e. Manufactured coarse aggregates shall consist of "very large", "large", "medium", and "small" aggregates and shall be of hard, strong, dense and durable pieces and shall be free from injurious amounts of soft or flaky particles salt, alkali, and vegetable matter and other deleterious substances (IS: 515),
- f. The aggregate shall be resistant to chemical or physical change such as cracking, swelling, softening, leeching, or other chemical alteration after its incorporation in concrete,

- g. As far as possible, coarse aggregates shall be of regular shape and free of flat or elongated particles.

iv) **Stacking**

Aggregate shall be stacked on a hard, dry and levelled patch of ground to prevent contamination from underlying materials. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

v) **Water**

- i) Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, sugar, organic materials or other substances that may be deleterious to concrete. Potable water is generally considered satisfactory for mixing concrete.
- ii) Water for manufacturing of concrete shall be approved by the Engineer-in-Charge.

2.3.3. Grade of Concrete

- i) All concrete mix for PCC and structural works shall be M15 and M20/ M25 or otherwise specified in the construction drawing.
- ii) The water cement ratio shall be kept to a minimum and not exceed 0.55 unless approved by the Engineer-in-Charge.
- iii) The coarse aggregate and sand shall be measured by measuring box of size 35cm (L) x 25cm (B) x 40cm (H), equivalent to one bag of cement or 0.035m³.
- iv) Cement shall be measured by weighing 50 kg.
- v) Sand shall be measured on the basis of its dry volume.
- vi) While measuring the aggregate; sacking, ramming or hammering shall not be permitted.
- vii) If fine aggregates are moist, allowance shall be made to the extent required for the bulking of moist sand, in accordance with IS: 2386 (Part-III). Allowance shall also be made for surface water present in the aggregates. All the allowances shall be maintained properly, to the satisfaction of the Engineer-in-Charge.

2.3.4. Mixing of Concrete

Concrete shall be thoroughly mixed in mechanical batch type concrete mixer or hand mixing on a clean water tight masonry or concrete slab or steel platform. **The decision of the mode of mixing i.e. by hand mixing or by mechanical mixer shall finally be made by the Engineer-in-Charge.**

2.3.4.1 Hand Mixing

- i) The mixing shall be done with gauge boxes on a clean water tight masonry or concrete slab or steel platform.
- ii) Measured quantity of sand shall be sprayed evenly. The cement shall be dumped on the sand and distributed evenly. The sand and cement shall be mixed thoroughly with spade turning the mixture over and over again, until it's even colour throughout and free from streaks. The measured quantity of coarse aggregate shall then be sprayed on the top of cement – sand mixture.
- iii) This shall be mixed at least three times by shovelling and turning over by twist from centre to side then back to the centre and again to the sides till the coarse aggregate gets evenly distributed in the cement – sand mixture. Water shall be added into the mixture and mix them until its even colour throughout.

2.3.4.2 Machine Mixing

- i) All concrete shall be thoroughly mixed in mechanical mixer of approved type so as to ensure uniform distribution of the components throughout the mass during the mixing operations.
- ii) Water shall not be added into the drum of the mixer, until all the cement and aggregates constituting the batch are already in the drum and dry mixed for at least one minute and are uniformly distributed. Water shall then be added and mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass but in no case shall mixing be done for less than two minutes and for at least 40 revolutions after all the water and materials are in the drum. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

2.3.5. Concrete Placing

- i) No concrete shall be placed in absence of the Engineer-in-Charge or his representatives.
- ii) Concrete shall be placed only in locations where authorised and no concrete or mortar shall be placed until formwork, preparation of surface and necessary clean-up have been done and checked & certified by the Engineer-in-Charge.
- iii) Foundations on which concrete is to be laid shall be firm dry soil, free from any soft mud or other objectionable material.
- iv) No concrete shall be placed in running water. Water shall, generally, not be allowed to flow over freshly poured concrete until final set has been achieved.
- v) Immediately, before placing concrete, all such surfaces upon which concrete is to be placed shall be thoroughly cleaned by the use of steel brooms, picks or other effective means, satisfactory to the Engineer-in-Charge.
- vi) Concrete shall not be allowed or caused to flow horizontally or on slopes in the forms.
- vii) Concrete placing on slope shall begin at the lower end of the slope and progress upward, thereby increasing compaction of concrete.
- viii) In order to reduce bleeding, slump shall not be more than necessary to achieve proper placement and consolidation.

2.3.6. Consolidation of Concrete

- i) Consolidation of newly placed concrete shall ordinarily be done with internal vibrator of appropriate type. The equipment for vibration shall have adequate power and shall be of high frequency, rugged and reliable.
- ii) Operators of vibrators shall be experienced and competent in handling these devices.
- iii) Ample stand-by units and parts, as well as, systematic servicing shall be ensured & provided.
- iv) Vibrators shall not be used to cause concrete to move more than a short distance laterally; otherwise fine wet material may run ahead and separate from the coarse aggregate.
- v) In case of small quantity of concrete, hand compaction shall be done with the help of tamping rods with the approval of Engineer-in-Charge. Compaction shall be completed

before the initial setting of concrete starts. After compaction, the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

- vi) Equipment and methods for the production, transportation, placing, consolidating, curing and finishing of concrete shall be subject to acceptance by Engineer-in-Charge.

2.3.7. Curing and Protection of Concrete

2.3.7.1. Curing with Water

- i) Plant and materials required for curing and protection of concrete shall be available at the location of each concrete placement before concrete placement is started and the water used for curing shall meet the requirements set out as specified in this specifications.
- ii) All concrete shall be protected against damage until final acceptance.
- iii) Exposed finished surfaces of concrete shall be protected from the direct rays of the sun for at least 72 hours after placement.
- iv) Fresh exposed concrete shall also be protected from the action of the rains, flowing water and mechanical injury.
- v) Curing water temperature shall not exceed 25°C or above the expected average ambient temperature (in the shade) of the 28-day curing period. Note that curing water should not be much cooler than the concrete; otherwise it may cause cracking from thermal stresses. Average anticipated ambient temperature (in the shade) shall be based on climatic records and forecasts approved by the Engineer-in-Charge.
- vi) No fire shall be permitted in direct contact with concrete at any time.
- vii) Concrete in which Portland cement is used shall be kept continuously wet for not less than 14 days, for normal concrete and 21 days for concrete containing Pozzolana or fly ash, by covering with water saturated materials such as jute bags wet burlaps, or a system of perforated pipes, mechanical sprinklers or porous hole or by any other approved method. Curing period where special cement may be used shall be specified by the Engineer-in-Charge.
- viii) The unformed top surface shall be moistened by covering with a water saturated material such as jute bags, or by other effective means as soon as the concrete has hardened sufficiently to prevent damage by water.

- ix) The water and other methods of curing shall be so handled as not to stain concrete surfaces, which shall be exposed.
- x) The actual method of curing adopted shall be subject to the approval of the Engineer-in-Charge.

2.3.7.2. Protection of Concrete

- i) Care shall be taken not to disturb the steel reinforcement projecting from any placement for at least 24 hours after the completion of such placement.
- ii) Finished concrete surface shall be protected from stains or abrasion and surface or edges likely to be injured during the construction period shall be kept properly protected by leaving forms in place or erecting protective covering satisfactory to the Engineer-in-Charge.
- iii) In case, the curing operations are inadequate or unsatisfactory, the Engineer-in-Charge shall be entitled to take such steps as deemed necessary to make good the deficiencies and defects.
- iv) Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below ground level, shall be protected from falling earth, during and after placing. Concrete placed in ground containing any deleterious substances, shall be kept free from contact with such ground or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer-in-Charge.

3. STEEL FOR REINFORCEMENT

3.1. Scope of Work

- i) The Specifications described herein relate to the work, which includes all labour, materials, equipment and services required for the supply, handling, storing, cutting, bending, binding, welding, cleaning, placing and fastening into position all reinforcing steel, as shown on the drawings, to be carried out by the Contractor under this Contract.
- ii) The Contractor shall produce the detailed bending schedules and placing drawings. These drawings shall be based on the outline reinforcement plans provided by the Engineer-in-Charge and subject to his approval.

3.2. Material

- i) The reinforcing bars shall meet the requirements of IS: 1786 (latest revision) and other relevant Indian Standards. Steel of high yield strength deformed bars conforming to IS: 1786 (latest revision).

3.3. Fabrication

- i) All bars shall be cut and bent in accordance with the bar bending schedules made by the Contractor which have been previously approved by the Engineer-in-Charge.
- ii) Reinforcing steel bars shall be cut and bent on the Site of the Works or at a fabricator's plant. Notwithstanding the above, a bar-bending machine and a representative stock of reinforcing steel shall be maintained on the Site, sufficient to allow minor revisions and additions to be carried out as required by the Engineer-in-Charge.
- iii) Reinforcing steel shall not be straightened or rebent in a manner that will damage the materials. Bars with kinks or bends other than those indicated on the drawings and schedules shall not be used.
- iv) Shorter lengths of steel shall not be used in places where continuous lengths are required as per the drawings without the approval of the Engineer-in-Charge. Shorter bars, if approved for use, shall be lapped or spliced to achieve continuity in accordance with the requirements of relevant Indian Standards or as approved by the Engineer-in-Charge.
- v) Bars shall be bent cold to the shape and dimensions shown on the drawings using a bar bender operated by hand or power to attain the proper radii of bends.
- vi) A standard 90-degree hook at the end of a reinforcement bar, if used, shall have an inner diameter not less than six times the diameter of the bar, up to a bar or 25 mm diameter, and shall have length of straight part beyond the curve of at least four times the diameter of the bar. Hooks shall be used only where shown on drawings or as required by the Engineer-in-Charge. The radii of bends for stirrups and ties shall not be less than four times the diameter of the bar for up to bars 16 mm in diameter, and six times the diameter for bars up to 25 mm diameter.
- vii) Heating of reinforcement bars to facilitate bending shall not be permitted.
- viii) The reinforcement available from rejected reinforced concrete shall not be used without prior approval of the Engineer-in-Charge.

3.4. Splicing of Reinforcement Bars

- i) Wherever it is necessary to splice reinforcement, the splices shall be made by lapping, or by mechanical means.
- ii) The steel bars shall be joined by providing lap joints in accordance with the requirements of the relevant Indian Standards or as approved by the Engineer-in-Charge. Splices at points of maximum stress shall however, be avoided. Splices in adjacent bars shall be staggered as directed by the Engineer-in-Charge. However, not more than 50% of bars shall be spliced at one section. Lap length of bars shall be as shown on the drawings and as per Indian Standards. This length may be changed by the Engineer-in-Charge in special locations.
- iii) If the contractor proposes to use welded splices in the reinforcing bars, the equipment, the materials and all welding and testing procedures shall be subject to the approval of the Engineer-in-Charge. The contractor shall carry out test welds as required by Engineer-in-Charge.
- iv) For welded splices for reinforcing bars, welding shall be done in accordance with relevant Indian Standard Codes. Electrodes for welding shall conform to relevant Indian Standards. But welding shall be done only to reinforcement bars of weldable grade.
- v) If the Contractor proposes to use mechanical couplings for reinforcing bars, he shall submit samples of the proposed coupling to the Engineer-in-Charge for approval prior to their proposed use.
- vi) Lap splices shall not be used for bars larger than 36mm diameter, which may be welded with the approval of the Engineer-in-Charge. In cases where welding is not practicable, lapping of bars larger than 36mm may be permitted, in which case, additional spirals shall be provided around the lapped bars. Where welding is approved, the Contractor shall prepare at least three samples of butt welds as directed by the Engineer-in-Charge. These specimens shall undergo tests by the Contractor in a recognised laboratory. If the results are satisfactory, the Engineer-in-Charge may allow welding instead of lap joints. The decision of the Engineer-in-Charge in this regard shall be final. The joint shall be butt welded by the electric-arc-method. The ends of the bars shall be cleaned of all loose scale, rust, grease, or other foreign materials and all welding shall conform to the relevant

Standard Specifications for welding of reinforcement bars used in reinforced concrete construction or as directed by the Engineer-in-Charge.

- vii) A weld shall be considered unsatisfactory if it fails to sustain a tensile stress of at least 90% of the tensile strength of the bar in which the weld has been made.

3.5. Execution

3.5.1. Placing

- i) Before being placed in position, the reinforcing steel shall be thoroughly cleaned of loose mill scale and rust, grease, paint, or other coatings that would reduce bond. All splashed concrete, which has dried on the reinforcing steel, shall be removed.
- ii) Reinforcing steel to be incorporated in the Works shall be placed accurately in positions as shown on the drawings and shall be held firmly in place during the placing and setting of the concrete.
- iii) Reinforcing steel shall be so placed that there will be a clear distance of at least 50mm between the reinforcing steel and edge of concrete or embedded metal Work.
- iv) Reinforcing steel shall be maintained in position by the use of small concrete blocks, steel chairs, steel spacers, steel hangers and other steel supports and ties, acceptable to the Engineer-in-Charge at sufficiently close intervals so that they do not either sag between supports or be displaced during placing of concrete or by any operation on the Work. Wood supports or spreaders shall not be used. All intersections shall be securely tied except that where the bar spacing is less than 300 mm in each direction, only alternate intersections need be tied.
- v) Binding wire and steel chairs shall not be carried to permanently exposed surfaces and shall be subject to the same requirements with regard to concrete cover as for the reinforcing steel.
- vi) Special care shall be exercised to prevent any disturbances of the reinforcement in concrete that has already been placed. The reinforcement after being placed in position shall be maintained in a clean condition until it is completely embedded in concrete.
- vii) The longitudinal bars shall be straight and fixed parallel to each other and to the sides of the form as shown on the drawings. The ties, links and stirrups connected to the bars shall be tightly fixed so that the bars are properly braced. The inside of their curved part shall be

in actual contact with the bars around which they are fixed and their position shall be exact as shown on the drawings.

- viii) Wire for tying reinforcement shall be black annealed iron wire. The diameter of wire shall not be less than 1.6 mm and shall have an ultimate strength of 5.63 tonnes per cm² and yield point of not less than 3.87 tonnes per cm².
- ix) “Bar-Grip” type joints shall be adopted by the Contractor for deformed bars of 25 mm diameter and above, subject to the approval of the Engineer-in-Charge. Splices at points of maximum stress shall however, be avoided. Splices in adjacent bars shall be staggered as directed by the Engineer-in-Charge.
- x) Sufficient concrete cover, as indicated on the drawings shall be provided to protect reinforcement from corrosion. All protruding bars from concrete to which other bars are to be attached and which shall be exposed to action of the weather for long period shall be protected from rusting by a thin coat of neat cement grout. Accurate record shall be kept at all the times of the number, sizes, lengths and weights of bars placed in position for different parts of the Work.
- xi) The Contractor shall avoid the use of two different grades of steel for one construction object.

3.5.2. Tolerance for Placing Reinforcing Steel

- i) Unless otherwise required by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances:
 - a) For effective depth of members of 300 mm or less, the variation shall be limited for spacing of rebars ± 25 mm, for cover -5 mm, $+2$ mm,
 - b) For effective depth of members of more than 300 mm, the variation shall be limited for spacing of rebars ± 25 mm, for cover -8 mm, $+2$ mm.
- ii) The cover shall, in no case, be reduced by more than one-third of specified cover or varied beyond the above tolerances whichever is less, unless approved by the Engineer-in-Charge.

3.5.3. Care of Placed Reinforcement and Concrete

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care shall be taken to ensure that at no time the radius of the bend is less than 8 times the diameters for deformed bars and 6 times the diameters for

plain mild steel bars. Care shall also be taken, when bending back bars, to ensure that the concrete around the bar is not damaged.

4. FORMWORK

4.1. Scope of Work

The work under this Chapter shall comprise supply of all labour, plant and material and the performance of all work necessary for the design, fabrication, supply, erection, maintenance and removal of formwork and false work to form concrete structures as shown on the Construction Drawings or as otherwise directed by the Engineer-in-Charge.

4.2. Definitions

- i) FORMS of FORMWORK shall mean the moulds into which concrete is placed.
- ii) FALSE WORK or SHORING shall mean the structural supports and bracings for forms used in any part of the Works.
- iii) CURVED FORMS shall mean any form not composed of plain surface and limits of curved forms shall not extend beyond the lines of tangency or intersections with flat surfaces.

4.3. Materials

4.3.1. Formwork

- i) Material used for form sheathing and lining shall be of wood, steel, or plywood. All materials used in formwork construction shall be of adequate strength and quality for their intended purpose.
- ii) Timber shall be sound, straight and free from warp, decay and loose knots and shall be dressed smooth. Except as expressly approved by the Engineer-in-Charge, all timber brought to the Site for use as forms, shoring or bracing shall be new material.
- iii) Steel Struts/ Props shall be straight. Buckled Props/ Struts shall not be used.
- iv) Plywood for use as form shall be mill-oiled and edge-sealed. Plywood shall be non-warping, non-wrinkling and manufactured with special water-proof glues. Plywood sheets shall be of uniform width and length.
- v) The surface of steel of steel lined forms shall be smooth. Forms with dents, buckled areas or other surface irregularities shall not be used.

- vi) Forms for concrete surfaces exposed to flowing water shall be lined with sanded, uncoated, plywood veneer. Steel or impermeable plastic liners will not be permitted.
- vii) Rough sawn boards may be used only for the lowest grade of surface finish (F1).
- viii) Re-use of forms will be allowed only if they are thoroughly cleaned and repaired and capable of producing the finish required for the concrete. Timber or plywood forms repaired with metal patches shall not be used.
- ix) Damaged forms that have deteriorated through use shall not be used.
- x) Where required, expanded metal fixed to the formwork shall be used in vertical construction joints.

4.3.2. Form Ties

- i) The type, number and positions of internal formwork supports and ties shall be to the approval of the Engineer-in-Charge. Form inserts or other similar permanently embedded items shall be accurately located and securely fastened in place. The number and location of form ties and bolts shall be such as to ensure that forms fit tightly against the concrete previously placed and remain in tight contact during operations.
- ii) The whole or part of such formwork supports and ties shall be removed without damage to the concrete so as to leave no part embedded nearer the surface of the concrete than the designed cover of the reinforcement or 50 mm in the case of un-reinforced concrete. Only metal portions of formwork support and ties shall be allowed to remain in place.
- iii) Through-bolts will not be permitted in water retaining walls or in underground linings.
- iv) Holes left after the removal of supports and ties shall be filled as described above under “**Cast in-situ Concrete**” of this Technical Specification, and shall be finished off neatly to the standard of the concrete surface. Such filling shall be adequately cured.

4.4. Erection of Formwork

- i) Formwork and false work shall be constructed only after the formwork drawings have been accepted by Engineer-in-Charge.
- ii) The Contractor shall construct the false work and formwork in strict accordance with the approved formwork drawings, one set of which shall be kept at the Site at all times. No change will be allowed without prior written acceptance of such change by the Engineer-in-Charge.

- iii) Formwork shall be erected and maintained such as to confine the concrete without loss of mortar and to produce required finished surfaces. Forms shall be set and maintained within the specified tolerance limit such that the complete concrete surfaces are within these limits.
- iv) Forms for concrete against which backfill is to be placed or which will not be exposed to view may be constructed of smooth tight boards not less than 25 mm nominal thickness.
- v) Forms for concrete exposed to view shall be constructed of steel or plywood, which is smooth and free from defects, with matched and sanded joints to give a symmetrical pattern over the entire area. Chamfer strips, 25 mm by 25 mm shall be used on all exposed corners, unless otherwise directed by the Engineer-in-Charge.
- vi) Any forms, which in the opinion of the Engineer are unsafe or inadequate in any respect, may, at any time, be rejected and the Contractor shall promptly remove the rejected forms from the works and replace them.
- vii) An adequate number of temporary clean-out holes or short weep-holes (pipes) shall be provided in the forms to secure the drainage of rainwater.
- viii) When a second lift is placed on hardened concrete, the number, location and tightening of ties at the top of the old lift and bottom of the new shall be such as to prevent any damage to concrete. The form of a new lift shall overlap the hardened concrete by at least 100 mm, to prevent abrupt irregularities.
- ix) Forms for sloping concrete surfaces shall permit their placing board-by-board or panel-by-panel immediately ahead of concrete placement so as to enable access for placement, vibration, and inspection of the concrete.
- x) All form surfaces shall be thoroughly cleaned before erection and shall be lubricated with a non-staining mineral oil. Excess oil shall be wiped off from the forms prior to placement of concrete. Oil shall not be allowed to come into contact with reinforcement steel or other embedded items.
- xi) Immediately before the concrete is placed, all forms shall be inspected to ensure that they are properly placed, sufficiently rigid, clean, tight, properly surface treated and free from excess of oil or other foreign materials. No concrete shall be placed until the formwork has been inspected and accepted by Engineer-in-Charge.

- xii) The formwork for the gate groove areas shall be accurately drilled to permit the placement of first stage anchor couplings and anchor-plates that are to be embedded in the primary concrete. Both, the anchor couplings and the anchor plates shall be fixed by fasteners, attachments and/or wires through the formwork, so that they stay in their position while concreting. The Contractor shall take care that the first stage anchors couplings and anchor-plates remain flush with the primary concrete face and that the couplings do not get plugged.

4.5. Finished Tolerances

Forms shall be so constructed that the finished concrete surfaces shall be of uniform texture.

4.6. Removal of Formwork

- i) Removal of forms shall be performed with care so as to avoid injury to the concrete and as soon as permissible in order to avoid delay in curing and repair of surface imperfections. Forms shall not be removed without the consent of the Engineer-in-Charge.
- ii) Forms shall not be removed until the concrete has attained sufficient strength to prevent damage to concrete. Damaged concrete shall be repaired or treated by the Contractor as soon as possible, but not before the Engineer-in-Charge has inspected such damage and agreed to the remedial works.
- iii) The elapsed time between the completion of concrete placing and the removal of forms shall generally be in accordance with IS: 456.
- iv) Considering the weather conditions and type of pour, the Engineer-in-Charge may modify the minimum elapsed time required before formwork can be removed from individual pours, and in case of formwork for beams and deck slabs it shall remain in place until concrete has developed the specified design strength.
- v) Notwithstanding the above or any approval given by Engineer-in-Charge, Contractor shall be fully responsible for ensuring that sufficient time has elapsed for the concrete to attain adequate strength before removal of formwork.
- vi) Forms shall be removed carefully so as to avoid cracking, spalling, peeling, breaking of edges or surfaces, or other damage to concrete. If it is necessary to use wedges, only wooden wedges shall be used against the concrete. Damaged concrete shall be repaired or

treated by the Contractor as soon as possible, but not before the Engineer-in-Charge has inspected such damage and agreed to the remedial works.

185. MASONRY AND ALLIED WORKS

18.3.45.1. Scope of Work

This section of the specification covers furnishing, installation including handling, transporting, batching, mixing, laying, scaffolding, centering, shuttering, finishing, curing, protection and repairing till handing over of brick masonry and allied works including DPC and plinth protection.

18.3.25.2. General Requirements

- i) The Contractor shall furnish all skilled and unskilled labour, plant, equipment, scaffolding, materials, etc. required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer-in-Charge.
- ii) All workmanship shall be in accordance with the latest standards and best possible practice. Masonry work shall be true to line & level as shown on drawing. All such masonry shall be tightly built against structural members and boned with dowels, anchors, inserts, etc. as shown on the drawings.
- iii) The Contractor shall carry out all works for setting out the building lines, locating the co-ordinates and establishing the reduced levels (RL's) on the basis of reference ~~mark~~ **benchmark**, which shall be furnished by the Corporation, at one or more locations.
- iv) Any approval, instructions, permission, checking, review, etc. whatsoever by the Engineer-in-Charge shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

18.3.45.3. Brick Masonry

- i) Properties of common building materials for the construction of brick masonry, viz., ~~burnt clay bricks, sand, lime~~ and cement shall be in accordance with this technical specification as given under "Cast in-situ Concrete". Burnt clay bricks to be used in the works shall conform to class- I of Assam -PWD specification for 'Properties, Storage and Handling of Common Building Materials'. ~~CHECK Besides clay bricks other type of bricks like fly ash lime bricks cured by autoclave process shall also be used whenever specified or shown on the drawing.~~
- ii) Mortar:

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- a) IS-~~2250~~: 2250 (Latest Revision) shall be followed as general guidance for preparation and use of mortar. Only cement-sand mortar shall be used. ~~Time shall be added for composite mortar with specific approval of the Engineer in Charge.~~
- b) Unless otherwise specified, mortar for brickwork having one or more brick thickness shall be 1-part cement and 6 parts sand by volume. Mortar for half-brick thick walls shall be 1-part cement and 4 parts sand by volume or as given in the construction drawing. Richer mix proportion shall be used, whenever specified or as directed by the Engineer-in-Charge.
- c) Sand shall be uniformly graded sand and conform to IS-~~2116~~: 2116 (Latest Revision).
- d) Cement and sand shall be thoroughly mixed dry either by hand or in a mechanical mixer and water shall then be added to obtain a mortar of the consistency of a stiff paste, care being taken to add just sufficient water for the purpose. Water shall be clean and free from injurious amount of deleterious matter such as oil, acid, alkali, salt and vegetable growth. Hand mixing may be allowed by the Engineer-in-Charge on clean approved platform in special cases only. Mortar shall be used as early as possible after mixing, before it begins to set and preferably within 30 minutes after water is added to the dry mixture. Mortar unused for more than 30 minutes shall generally be rejected and removed from site of work. However, the Engineer-in-Charge may allow the use of mortar up to 2 hours.
- e) Surplus mortar droppings while laying masonry, if received on a surface free from dirt, may be mixed with fresh mortar if permitted by the Engineer-in-Charge, who may direct for addition of extra cement and this shall be implemented.

iii) Laying:

- a) IS-~~2212~~: 2212 (Latest Revision) shall be followed as general guidance for construction of brick masonry. Vat/tank of suitable size shall be provided by the Contractor for soaking of the bricks. Bricks shall be soaked in water before use for a period generally not less than 6 hours so that the water just penetrates the whole depth of the bricks. Bricks shall be laid in by hand and not thrown inside the

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tank. Bricks shall be taken out sufficiently in advance so that these are skin dry at the time of laying.

- b) Bricks shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond. Closers in such cases shall be cut to the required size and used near the ends of the walls, next to quoin headers.
- c) Bricks shall be laid generally with frogs upwards. A layer of mortar shall be spread on the full width and over a suitable length of the lower course. Each brick shall be properly bedded and set home (in position) by gently tapping with the trowel handle or with a wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of a course, all vertical joints shall be fully filled from the top with mortar. The thickness of joints shall be kept uniform and shall not exceed 10 mm. Bricks shall be so laid that all joints are full of mortar.
- d) All face joints shall be raked to a minimum depth of 15 mm by raking tools during the progress of brickwork, when the mortar is still green, so as to provide proper key for the plaster or pointing to be done. When plastering or pointing is not required to be done the joints shall be struck flush and finished at the time of laying.
- e) Brickwork in walls shall be taken up truly plumb. All courses shall normally be laid truly horizontal unless indicated to be laid on slope and all vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. Brick wall shall be constructed with at least one plain face with proper alignment.
- f) All connected brickwork shall be carried up simultaneously and no portion of work shall be left more than one metre below the rest of the work. Where this is not possible, in the opinion of the Engineer-in-Charge, the work shall be raked back according to bond (and not toothed) at an angle not steeper than 45 degrees. The work done per day should not be more than one metre height.

- g) All iron fixtures, pipes, water outlets, hold fasts for doors and windows, etc. which are required to be built into the brickwork shall be embedded in their correct position in mortar or cement concrete as the work proceeds as per directions of the Engineer-in-Charge.
- h) All brickwork shall be built tightly against columns, floor slabs or other structural parts and around door and window frames with proper distance to permit caulked joint. Where drawings indicate that structural steel columns and spandrel beams are to be partly or wholly covered with brickwork, the bricks shall be laid closely against all flanges and webs with all spaces between the steel and brickwork filled solid with mortar not less than 10 mm in thickness.
- i) The top courses of all plinth, parapet, steps and top wall below R.C.C. shall be laid with brick on edge unless otherwise specified. Care shall be taken that the bricks forming the top courses and ends of walls are properly radiated and keyed into position as shown on the drawings.
- j) Scaffolding shall be strong enough to withstand all the dead, live and impact loads which loads, which are likely to come upon it. It shall also be so designed as to ensure the safety of the workmen using them.
- k) For all brick masonry except for exposed brickwork, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in header course for the purpose. Only one header for each pole ~~shall~~ shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.
- l) In case of joining old brickwork with new ~~brick-work~~brickwork, the old work shall be toothed to the full width of the new wall and to the depth of quarter of a brick in alternate courses. It shall be cleaned of all dust, loose mortar, etc. and thoroughly wetted before starting new ~~brick-work~~brickwork. Thickness of each course of new work shall be made equal to the thickness of the corresponding course of the old work by adjusting thickness of horizontal mortar joints.

- m) The face of the brickwork shall be cleaned on the same day on which brickwork is laid and all mortar droppings removed promptly.
- n) Template (bed block) of plain or reinforced cement concrete shall generally be provided to support ends of R.C.C. beams. Top surface of the wall shall be suitably treated as per direction of the Engineer-in-Charge so as to minimise the friction to movement of the concrete slab over the bearing.
- o) Brickwork shall be protected from rain by suitable covering when the mortar is green. Masonry work shall be cured by keeping in constantly moist on all faces for a minimum period of seven days. Brickwork carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

18.3.75.4. Plinth Protection

- i) Plinth of buildings shall be protected with brick-on-flat paving of minimum 750 mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks conforming to class 50 (min.) of IS-~~1077~~: 1077 (Latest Revision) in cement mortar 1:4 (1 cement: 4 sand) over a 75 mm thick bed of flat laid brick & compacted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The bricks shall be hard, durable & free from defects. Alternately, plinth of the building shall be protected with 750mm width and 100mm thick PCC (M15) from the external periphery of the building. The PCC shall be laid over a 75mm thick bed of flat brick soling and compacted with sand. The plastering at top surface and outward slope shall be maintained as flat brick protection.
- ii) The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down, hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50 m or as directed by the Engineer-in-Charge.
- iii) Over this, 75 mm thick bed of bricks on flat shall be laid in 1:4 cement mortar with a minimum outward slope of 1 in 50. The soaking of bricks shall be done as mentioned earlier

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in this specification. The bricks shall be laid on flat in Diagonal Bond or other pattern as specified or as directed by the Engineer-in-Charge.

- iv) Each brick shall be properly bedded and set home by gentle tapping with handle or trowel or wooden mallet. It's inside face shall be applied with mortar before the neat brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

~~iv-v)~~ The properly cured surface shall be finished with 15mm thick 1:2 (1 cement: 2 sand) plaster with a floating coat of neat cement finish.

- vi) Along the periphery of the Plinth Protection Works, a peripheral drain of size 300mm wide, depth 250mm (average) with a bed slope 1 in 150 with initial depth of 100mm shall be provided with plain cement concrete (1:3:6) 100 mm thick sides & 100mm thick bed over brick flat soling and finished with 15mm thick cement plastering in proportion 1:3 (1 cement: 3 sand) with a floating coat of neat cement slurry.

18.3.85.5. Damp Proof Course (DPC)

- i) All walls of the building shall be provided with a damp proof course generally immediately below the underside of the ground floor or as shown on the drawings. This shall run without break throughout the length of the wall, even under door or other openings.

~~18.4ii)~~ Damp proof course shall be 25 mm thick (unless, otherwise specified) consisting of cement concrete in proportion 1:1.5:3, (1 cement: 1.5 sand: 3 graded stone aggregate 10 mm nominal size) mixed with water proofing cement additive as approved by the Engineer-in-Charge. The additive shall be used in proportion recommended by the manufacturer.

- iii) The surface of masonry work shall be levelled and prepared before laying the cement concrete. Edges of DPC shall be straight and even. The side shuttering shall consist of wooden forms and shall be strong and properly fixed so that it does not get disturbed during compaction and 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 side shuttering are removed the surface should be smooth without any honeycombing.

6. PLASTERING AND ALLIED FINISHES TO MASONRY AND CONCRETE

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18.4.16.1. Scope of Work

- i) This specification covers furnishing, installation, repairing, finishing, curing, testing, protection, staging & scaffolding, all tools & plants, maintenance till handing over of plastering and allied finishes to masonry and concrete. This shall also include the work to be done to make surfaces suitable for receiving the finishing treatment and any further finishing treatment over base finishing treatment.
- ii) Before commencing work on the finishing items the Contractor shall obtain the approval of the Engineer-in-Charge regarding the scheduling of work to minimise damage by other contractors. He shall also undertake normal precautions to prevent damage or disfiguration to work of other contractors and other installations.

18.4.26.2. Preparation of Surface

- i) All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brushes to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.
- ii) For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.
- iii) At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base to the required level shall be brought to the notice of the Engineer-in-Charge and his approval shall be taken regarding the method and extent of rectification work required.
- iv) Prior to commencement of actual finishing work, the approval of the Engineer-in-Charge shall be taken as to the acceptability of the base.

18.4.36.3. Plastering

- i) Mortar for plastering shall be as specified in the drawings and in the Schedule of Items.
- ii) For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on watertight platform and minimum water added to achieve working consistency.

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iii) No plaster, which has stood for more than half an hour shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

18.4.46.4. Wall Plaster

The wall plaster shall be laid in a single coat of 12 mm thickness on the even surface of brickwork and 15 mm on the rough surface of the brickwork. The mortar shall be dashed on the prepared surface with a trowel and finished smooth by trowelling on the surface. The standard of finish expected is high and shall conform to IS: 2394. Internal wall plaster shall be carried out on jambs, lintel and sill faces, top and undersides, etc. as shown in the drawing or as directed by Engineer-in-Charge. Wall plaster shall commence at top and work downwards.

18.4.76.5. Grooves In Plaster

Where specified in drawings rectangular grooves as per drawings shall be provided in external plaster by means of timber batons fixed on plaster when plaster is still in green condition. Batons shall be carefully removed after initial set of plaster and broken edges and corners made good. All grooves shall be uniform in width and depth and shall be truly plumb and correctly aligned.

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18.4.8 Lime Punning (Neeru Finish)

~~3.5.4. For plastered surface, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, sieved and aged, mixed with 1 part of clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall not be less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workmen and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer-in-Charge.~~

18.4.9 Plaster of Paris Punning

~~3.5.6. Surfaces where specified shall be finished with Plaster of Paris punning. The material shall be approved by the Engineer-in-Charge. Thickness of punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.~~

18.4.10 6. Application of Plaster

- i) Plaster, 12mm or 15mm thickness shall be applied in single coat. To ensure even thickness and true surface, wooden screed 75mm wide and of the thickness of the plaster shall be fixed vertically about 2000mm to 3000mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork/ concrete work with plaster. All vertical edges of brick pillars, door jambs etc. shall be chamfered or rounded off as directed by the Engineer-in-Charge. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer-in-Charge shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.
- ii) Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. The decision as to when the plaster has ~~hardened, hardened~~ will be given by the Engineer-in-Charge. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

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18.4.126.7. Finish

i) General:

~~ly, the~~The standard finish shall be used unless otherwise shown on drawing or directed by the Engineer-in-Charge. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer-in-Charge regarding the texture, colour and finish.

ii) Standard Finish:

~~Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise t~~The interior plaster shall ~~generally~~ be finished to a smooth surface. The exterior surface shall ~~generally~~ be finished with a wooden float.

iii) Neat Cement Finish:

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of 1 (one) kg. per m² and rubbed smooth with a trowel.

iv) Rough– Cast– Finish:

A wet plastic mix of 3 parts coloured cement, 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm, as approved by the Engineer-in-Charge) shall be thrown on to the wall by means of plaster's trowel and left in the rough condition. The mix shall again be dashed over the vacant spaces, if any, so that the surface represents homogeneous surface of sand mixed with gravel.

v) Pointing:

Pointing shall be of the type such as 'ruled', 'cut' or 'weather struck' etc. as indicated in the drawing. Following general specifications shall apply to all types of pointing. All joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12 mm. The mortar shall be pressed into the raked out joints with a pointing trowel either flush, sunk or raised according to the type of pointing required. The mortar shall not spread over the corners, edges, ~~surfaces and surfaces~~ of masonry. The pointing shall then be finished with the proper tool as required for the particular kind of pointing specified. The superfluous mortar shall then be cut off from the edges of the lines and the surface mortar

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shall then be cut off from the edges of the lines and the surface finish shall be such that the pointing is to be exact size and shape as stipulated.

~~18.4.13vi)~~ Acceptance Criteria

Finish to masonry and concrete shall fully comply with the drawings specifications, approved samples and instructions of the Engineer-in-Charge with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the specification or as shown on drawing.

7. FLOOR FINISHES AND ALLIED WORKS

~~18.5.17.1.~~ **Scope of Work**

- i) This specification covers furnishing, installation, finishing, curing, testing protection, maintenance till handing over various type of floor finishes and allied items of work.
- ii) The base to receive the finish is covered under other relevant specifications.
- iii) Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer-in-Charge keeping in view the activities of other agencies working in that area. However, the Contractor for finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

7.2. Brick Soling under Foundations / Tie beams

i) **Scope of the Work:**

The work covered under this specification includes all types of soling works by bricks laid under foundations, hand picked, complete as per specification mentioned below or as directed by the Engineer-in-Charge.

ii) **Materials:**

The Bricks shall be best quality picked jhama bricks. The bricks shall be hard, durable, free from defects and shall be approved by the Engineer-in-Charge.

iii) **Surface Preparation:**

The bed over which brick soling is to be laid shall be cleared of all loose materials, levelled, watered, compacted and got approved by the Engineer-in-Charge before laying of brick

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soling. Any trenches if shown in the drawing or as required by the Engineer-in-Charge shall be got done before soling is started.

iv) **Workmanship:**

Over the prepared surface, the bricks shall be set as closely as possible, well packed, and firmly set. The bricks shall be laid on flat in one layer of 75mm thickness. The packing the bricks in position, the interstices between them shall be carefully filled with sand to obtain a hard compact surface. The entire surface shall then be watered and consolidated with mechanical or sufficiently heavy wooden tampers and log hammers as approved by the Engineer-in-Charge. After compaction, the surface shall present a clean look. Adequate care shall be taken by the contractor while laying and compacting the brick soling so that the concrete surfaces in contact with the soling shall not get damaged.

7.3. Stone Soling under Floor

i) **Scope of the Work:**

The work covered under this specification includes all types of soling works by stone aggregate laid under floors, complete as per specification mentioned below or as directed by the Engineer-in-Charge.

ii) **Materials:**

The stone shall be hard and free from impurities. However, detailed specification of stone materials has been given in the Chapter "Cast in Situ Concrete"

iii) **Surface Preparation:**

The base over which the soling should be laid is cleared of all the loose materials, formworks, props, etc. Any leftover building raw materials over the base surface, that should be shifted beforehand to clear the area.

iv) **Laying and Compaction:**

The stone shall be laid over prepared flat surface and sand shall be spread over the stone completed to the required depth after sprinkling water. Each layer of the stone shall be so laid that the final completed depth after sand blinding and watering shall not exceed 150 mm. The compaction shall be carried out either manually or mechanically to the satisfaction of the Supervision Team. The compaction shall be carried out in such a way that minimum 95% of proctor density shall be attained.

7.4. Precast Chequered Concrete Tiles

7.4.1. Scope:

- This scope of the work includes providing, supplying and laying of precast concrete chequered tiles of suitable strength and quality including filling of Joints with 1:4 Cement Sand Mortar and all tools & plants and labour required for successful completion of the same as per the technical specification.

7.4.2. Types:

7.4.2.1. Chequered Concrete Tiles:

- Chequered tiles are cement concrete tiles having grooves on the surface of the tile making it anti- slippery. The area of chequered grooves should not be less than 2 percent of the total surface area of the tile. The chequered grooves should not be less than 2 percent of the total surface area of the tile. The chequered groove can be in any shape and length, but the depth of the grooves should not be less than 3 mm.

7.4.2.2. Plain Chequered Tiles:

- Chequered tiles, in the manufacture of which pigments and stone chips are not used in the wearing surface.

7.4.2.3. Coloured Chequered Tiles:

- Chequered tiles having a plain wearing surface wherein pigments are used but not stone chips.

7.4.2.4. Terrazo Chequered Tiles:

- Chequered tiles at least 25 percent of whose wearing surface is composed of stone chips in a matrix of plain or coloured Portland cement mixed with or without pigments and mechanically ground and filled.

7.4.2.5. Monolayer Tiles:

- Chequered tiles on which there is only one layer that is wearing layer, and which does not contain backing layer.

7.4.2.6. Double Layer Tiles:

- Chequered tiles which contain a wearing layer as well as a backing layer.

7.4.3. Materials:

7.4.3.1. Cement:

- Cement used in the manufacture of tiles shall be 33 Grade ordinary Portland cement conforming to IS: 269 or 43 Grade ordinary Portland cement conforming to IS: 8112 or 53 Grade ordinary Portland cement conforming to IS: 12269 or Portland Pozzolana Cement (Fly-Ash Based) conforming to IS: 1489 (Part- 1) or Portland Pozzolana Cement (Calcined Clay Based) conforming to IS: 1489 (Part 2) or Portland slag cement conforming to IS: 455 or rapid hardening Portland cement conforming to IS: 8041 or white Portland cement conforming to IS: 8042.

7.4.3.2. Aggregates:

- Aggregates used in the backing layer of tiles shall conform to the requirements of IS 383. For the wearing layer, unless otherwise specified aggregates shall consist of marble chips or any other natural stone chips of similar characteristics and hardness, marble powder or dolomite powder or mixture of the two.

7.4.3.3. Pigments:

- Pigments, synthetic or otherwise, used for colouring tiles shall have durable colour. It shall not contain matters detrimental to concrete and shall according to the colour required be one of the following or their combination:

Pigments	Relevant Indian Standards
Black or Red or Brown Pigments	IS 44
Green Pigments	IS 54
Blue Pigments	IS 55 or IS 56 or IS 3574 (Part- 2)
White Pigments	IS 411
Yellow Pigments	IS 50 or IS 3574 (Part- 1)

- Colours other than mentioned above may also be used.
- The pigments shall not contain Zinc compounds or organic dyes.
- Lead pigments shall not used unless otherwise specified by the client/ Engineer-in-Charge.

7.4.4. Other Technical details of the product:

- Chequered cement concrete flooring tiles shall be manufactured from a mixture of cement, natural aggregates, and colouring materials where required, by pressure

process or vibration or both so that the tiles meet the required strength. When manufactured by pressure process alone, the tiles shall be subjected to a pressure of not less than 14 N/mm².

- The tiles shall be manufactured in single layer/ mono-layer or in double layer.
- The proportion of cement to aggregate in the backing of the double layer tiles shall be not leaner than 1: 3 by mass. Single layer/mono-layer tiles shall have only the wearing layer.
- Where colouring material is used in the wearing layer, it shall not exceed 10 percent by mass of cement used in the mix.
- On removal from the mould, the tiles shall be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of this standard.

7.4.5. Dimensions

- The size of chequered cement flooring tiles shall be as given in the following Table.
- Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles in the floor shall have dimensions which shall be such as to make two half tiles when joined together, to match with the dimensions of the one full tile.

Table: Size of Cement Concrete Tiles

Sl. No.	Length	Breadth	Minimum Thickness	
			Single Layer of Mono Layer Tile	Double Layer Tile
1.	200	200	17	22
2.	250	250	17	22
3.	300	300	20	25
4.	400	400	20	25

7.4.6. Tolerances

- 7.4.6.1. Tolerances on length or breadth of tiles shall be ± 1 mm. In addition, the difference in length of side between the longest side and the shortest side in the sample shall not exceed 1 mm.
- 7.4.6.2. Tolerance on thickness shall be +15 percent of the minimum thickness (no tolerance on the negative side shall be permitted). In addition, the difference in thickness between the

thickest and the thinnest tile in the sample shall not exceed 10 percent of the minimum thickness.

7.4.6.3. Thickness of Wearing Layer:

- The thickness of wearing layer measured from the top of the chequers shall be as specified in the following Table.

Table: Thickness of Wearing Layer for Double Layer Tiles

Sl. No.	Class of Tile	Minimum Thickness of Wearing Layer for Double Layer Tile
1.	Chequered tiles, plain or coloured or terrazzo with chip size varying from the smallest up to 12 mm, for general purpose	5
2.	Chequered terrazzo with chip size varying from the smallest up to 20 mm, for general purpose	6
3.	Chequered tiles, plain or coloured or terrazzo with chip size varying from the smallest up to 20 mm, for heavy duty	6

- The thickness of the wearing layer shall be measured at several points along the fracture line of the tile that was tested for wet transverse strength. The arithmetic mean of the two measurements which yielded the lowest value shall be the minimum thickness of the wearing layer.

7.4.7. General Quality

- Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of the upper layer. The upper layer of the tiles shall be free from projections, depressions, cracks (hair cracks not included), holes, cavities and other blemishes. The edges of the wearing layer may be rounded.

7.4.8. Finish

- The colour and texture of the wearing layer shall be uniform throughout its thickness. No appreciable difference in the appearance of the tiles, from the point of view of

colour of aggregate, its type and its distribution on the surface of the wearing layer shall be present.

- Exact matching of the shade of the colour may not be always possible in actual manufacture. There may be some variations in colour in different batches due to variations in the basic colour of raw materials.

8. METAL DOORS, WINDOWS, VENTILATORS, LOUVERS, ROLLING SHUTTERS AND GRILLS, ETC.

8.1. Scope of Work

The work in general shall consist of supply and/or erecting installing of all metal doors, windows, ventilators, louvers, glazed partitions etc. as shown on drawings with all materials complete excluding supply of glass and glazing. Supplying and/or fixing of all door and window accessories and hardware is also included in the scope.

8.2. Installation

i) Materials:

- a) Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.
- b) Steel sheets for frames, shutters, louver blades etc. shall be of a gauge mentioned in the specification.
- c) Hardware and fixtures shall be as per construction drawing and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Maintaining the quality of the fixtures as per the construction drawing shall be the responsibility of the contractor. All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 (Latest Revision). Each closer shall be guaranteed against manufacturing defect for one year and any defects found within this period shall be rectified or the closer replaced free of charge.
- d) The Contractor shall submit samples of each type of hardware to the Engineer-in-Charge. The approved samples shall be retained by the Engineer-in-Charge for comparison of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

- e) The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer-in-Charge. In general the mastic for fixing of metal frames shall be as per IS ~~1081~~: 1081 (Latest Revision) and/or as approved by the Engineer-in-Charge.

8.3. Fabrication of Steel Doors, Windows, Ventilators, Louvers etc.

i) Doors Frames:

- a) Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitred corners shall be used. Rubber door silencers shall be furnished for striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floors shall be supplied. Frames shall be brought to site with floor ties/weather bars.

ii) Double Plates Flush Door Shutters:

- a) Door shutters shall be 45 mm thick completely flush designed and shall comprise of two outer sheets of 1mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 1mm thick stiffeners, spot welded in position at not more than 150 mm centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by IS Angles running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper bevel on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Where shown on drawing or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.
- b) Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push plates and other surfaces, hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawings, provision shall be made for fixing glazing, vision panels, louvers etc. Glazing moulding shall be of 1mm thick steel sheets.

iii) **Single Sheet Door Shutters:**

- a) Single sheet doors shall be made from best quality 1mm thick mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening ~~rail which~~rail, which shall convey the lock and other fixtures. The frames shall be made from best quality 1mm thick mild steel sheets.~~;~~
- b) Wherever required as shown on drawings, provision for fixing glass panes, louvers etc. shall be made. Manufacturing shall be done as specified for double plate flush steel doors.

iv) **Sliding Doors:**

Sliding doors shall be either double plate or single plate construction as called for in the drawings and schedules, made out of 1mm thick steel sheets with adequate stiffeners.~~.-~~The contractor shall specify the weight of the door in the shop drawings and submit the manufacturer's catalogue of the sliding gear he proposes to use. Doors shall close positively to exclude ~~rain-water~~rainwater from seeping in. When called for in the schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

v) **Door Threshold:**

Door thresholds shall be provided as shown on drawing. Door without threshold shall have bottom tie of approved type.

vi) **Steel Windows, Sashes, Ventilators etc.:**

- a) They shall conform in all respects to IS ~~:-1038:~~ 1038, IS: 7452 & IS ~~:-1361:~~ 1361 (Latest Editions) and/or as shown on drawings. The details as called for in the above codes shall be applicable for coupling, mullions, transom weather bars, pivot arrangements for ventilators etc. or as shown on drawings or called for in the Schedule of Items.~~;~~
- b) Metal rolling shutters and rolling grills shall conform in all respects to. IS ~~:-6248:~~ 6248 (Latest Revision).~~;~~
- c) All welds shall be dressed flush on all exposed and contact surfaces.~~;~~
- d) All windows shall be outside glazed fixed with ~~putty or~~ metal glazing beads as shown on the drawing.

vii) **Rolling Steel Shutters / Grills:**

- a) The specification covers the design supply of material, fabrication, delivery and erection of Rolling Shutter/grills with motor driven and/or manual operation including all accessories as hereinafter specified. All Electrical work shall be in strict accordance with the latest Indian Electricity Rules.
- b) For rolling shutters shall be made from tested bright cold rolled, annealed 80 x 1.25mm thick M.S. Laths with 1.25mm thick top cover, machine rolled at 75mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- c) Rolling grills shall be constructed out of a 6mm dia rods at 35mm on centres running horizontally, flexibly connected with vertical links spaced not more than 200mm centres. Alternatively, rolling grills shall be made from perforated slates of approved design reinforced with 6mm dia. rods.
- d) End locks shall be heavy type M.C./C.I. and shall be provided at each end of alternate slates.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 150 Kg/m² The minimum thickness of guide to be of 12G or specified as per the drawings.
- f) Shafts shall be of steel pipe of sufficient size to carry the torsion load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operations.
- g) Bottom bars shall be finished with two angles not less than 6 mm thick external shutters. When shown on drawings a flexible weather strip shall be applied to make tight contact with the floor.
- h) Hoods shall be formed of not less than 1.25mm thick steel, suitably reinforced to prevent sag.
- i) Locks shall be ~~slidesliding~~ bolts and hasp or cylinder lock operable from one or both sides. Provision to securing hand chain with padlock, provision for removable handle for hand cranks etc. shall be made as desired by the Engineer-in-Charge.
- j) Power unit shall be suitable for 3 ~~phasephases~~, 50 ~~eyelecycles~~, 400_volt A.C. Power supply or as per manufacturer's requirements and shall be either floor or wall

mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor standard power unit shall include a magnetic brake, a reversing starter with built in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated.

- k) It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.
- l) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.
- m) Reduction gears shall be high strength grey cast iron, machine moulded from machine cut patterns.
- n) Manually operated shutters/grills shall be easily operable by one person. The speed of operation shall be about 0.3 metres per second. In general, manually operated shutters shall be push pull type for openings up to 9 m² in area. Larger shutters shall be ~~either chain and~~ either chain or gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer-in-Charge.
- o) Power operated shutters/grills shall be operable from a push button station conveniently located beside the door or as shown on drawings. On emergency hand chain/crank operation shall be provided for use in case of failure of the electric system.

viii) **Welding:**

The joints for steel doors, windows, ventilators etc. shall be electrically flash butt welded joints at all corners and junctions to form a solid fused right angle joint.

ix) **Shop Coat of Paint:**

- a) The shop paint for steel doors, windows, etc. shall be best zinc chromate primer paint from approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint.

- b) Where called for in the Schedule of Items, all steel door, windows etc. shall be hot dip galvanized to give a coating weight of 460 to 610 gr/m². One coat zinc chromate primer coat shall then be applied as shop paint.
- c) Rolling steel shutters and grills shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanised and subsequently painted one coat of zinc chromate for adhesion of field coat.

8.4. Handling & Storage of Fabricated Materials

- i) All metal doors, windows etc. shall be packed and crated properly before despatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.
- ii) When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect shall promptly be brought to the notice of the Engineer-in-Charge.
- iii) All metal doors, windows etc. shall be stored in a way to prevent damage or distortion.

8.5. Assembly & Erection at Site

- i) In general, the fixing of doors, windows, ventilators, louvers etc. shall conform to IS: 1081 and/or as shown on drawings. The Contractor shall assemble and install all steel doors, windows sashes, fixed metal louvers etc. in respective places as shown on drawings, keeping proper lines and levels, and in approved workman like, manner, to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer-in-Charge. If required by the Engineer-in-Charge, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chasms, etc. required for fixing shall be made by the contractor and made good again as per original, after installation, without any extra change.
- ii) After installation of door, windows etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

iii) The contractor shall bring to the site the mastic cement in original sealed container of manufacturer and shall apply it as per the instruction, for all frame supplied by the Contractor and caulking done properly as per drawings, specifications and as per instruction of the Engineer-in-Charge.

iv) Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipment have been installed in rooms.

8.6. Acceptance Criteria

i) For Fabricated Items:

- a) Overall dimensions shall be within +/- 1.5 mm of the size shown on drawings.
- b) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.
- c) Door leaves shall be undercut where shown on drawings.
- d) Doors, windows, frames, etc. shall be on a true plane, free from warp or buckle.
- e) All welds shall be dressed flush on exposed and contact surfaces.
- f) Correctness of location and smoothness of operation of all shop installed hardware and fixtures.
- g) Provision for hardware and fixtures to be installed at site.
- h) Glazing beads shall be cut with mitred corners.
- i) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- j) Shop coats shall be properly applied.

ii) For Installed Items:

- a) Installation shall be at correct locations, elevations and in general on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly as per drawings, with mastic caulking at gaskets, weather strips etc. complete.
- d) All frames on external wall shall be mastic caulked to prevent leakage through joint between frames and masonry.

- e) All operable sections shall operate smoothly without jamming.
- f) Lock, fasteners etc. shall engage positively. Keys shall be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

iii) For rolling shutters and grills:

- a) Shop Inspection: After completing the manufacture of the different components of the rolling shutters, an arrangement for shop inspection by the Engineer-in-Charge shall be made to check the conformity with approved shop drawings.
- b) Field Inspection: After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer-in-Charge. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.
- c) The Contractor shall give one year guarantee for the successful operation of the shutters.

It shall be the responsibility of the Contractor to see that the material is protected from mortar, paint, ~~plaster~~ and plaster.

9. GLASS AND GLAZING

9.1. Scope of Work

The work in general shall consist of supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as shown on drawings.

9.2. Installation

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, unless otherwise stated from approved manufacturer ~~like Hindustan Pilkington or equivalent~~, having uniform refractive index and free from flaws specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

9.3. Materials

- i) Glare reducing, tinted, or heat absorbing glass shall be “Calorex” of Hindustan Pilkington or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.
- ii) Clear glass shall be flat drawn sheet glass and shall be at least 6 mm thick conforming to IS: 2835 (Latest Revision). Sheet glass for doors shall be minimum 6mm thick clear glass & 5mm thick frosted glass.
- iii) Wired glass shall be thick rolled glass with centrally embedded 24 G wire mesh of Georgian type. This may be of clear or coloured glass as shown in drawings and shall conform to IS: 5437 (Latest Revision).
- iv) Ground (obscure) glass shall have a cast surface on one side.
- v) Coloured and figured glass shall be as per approved sample.
- vi) Composite double glazing shall be made of double glazing of two 6 mm thick clear float glass either both sheets of tinted glass or one glass tinted and other plain or both sheets of plain sheet glass. Both the glasses shall be separated by an air gap of 6 mm. The trapped air shall be kept dry by means of suitable desiccant. The sealing shall be under strict quality control. The composite glazing shall be procured as finished product from reputed manufacturers. Toughened glass conforming to IS: ~~2553~~: 2553 (Latest Revision) shall be used.
- vii) In general, the putty shall conform to IS: 419 (Latest Revision) and be of best quality from approved manufacturer. It shall be brought to site in manufacturer’s original packing. Quick setting putty shall be used for windows and sashes except when glare reducing glass is used where it shall be of non-setting type.
- viii) Neoprene gaskets with snap-fit glazing shall be fixed as per manufacturer’s instructions and shall fit firmly against the glass to give a leak-proof installation.
- ix) Glazing, Setting and Finishing:
 - a) All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.
 - b) All glass shall be thoroughly cleaned before setting in position. Each glass pane shall be held in place by special glazing clips of approved type. Four glazing clips shall be provided per glass pane except for large panes where six or more clips shall be used as

per the instructions of the Engineer-in-Charge. All holes that may be necessary for holding the clips glazing beads and all other attachments shall be drilled by the Contractor.

- c) Glass panes shall be set without springing, and shall be bedded in putty and back putties, except where moulding or gaskets are specified. Putty, mastic cement etc. shall be smoothly finished to a true even line. Obscure and figured glass shall be set with smooth side out.
- d) After completing of glazing work, the Contractor shall remove all dirt, stains ~~and~~ excess putty, clean the glass panes and leave the work in perfectly acceptable conditions. All broken, racked or damaged glass shall be replaced by new ones at Contractor's own cost.

9.4. Acceptance Criteria

- i) All installations shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or ungrounded edges.
- ii) Glazing shall be carefully done to avoid direct contact with metal frames.
- iii) All glasses shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.
- iv) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer-in-Charge.

10. SUSPENDED CEILING

10.1. Scope of Work

The work under this Section shall include the supply and installation of suspended ceiling together with the suspension system as shown on drawings or specified in Schedule of Items with all materials, labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer-in-Charge.

~~10.2.~~

~~10.3.~~10.2. Suspension System

i) **General:**

- a) Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid, if any, and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.
- b) All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling board or sheets in a true and level plane without exceeding a deflection of 1/500th of the span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. The scope of this item also includes all drillings of structural concrete or welding to steel for installation of the suspension system. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.
- c) All wood supports shall be painted with two coats of approved wood preservative before erection.

ii) **Metal Grid Suspension System:**

- a) Aluminium grid ceiling system shall be "Beadlok" as manufacturer by "W.A. Beardsell and Co. Pvt. Ltd.", or approved equivalent.
- b) Angle cleats or other suitable fixing device shall be fixed to the structural section, beam or slab above for fixing of hangers. Runners shall be hung by M.S. flats, angles or rods as shown on the drawings. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross tees shall be as shown on drawings.
- c) The cross tees shall intersect main tees in pattern shown on drawings and positively locked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and suspended ceiling end tees shall rest on the mouldings, unless otherwise shown on drawings.

~~10.4.~~10.3. Aluminium Lineal Ceiling System Panel

i) **Materials:**

Ceiling Panel shall be of best quality material in properties and thickness as shown in the construction drawings. The contractor shall submit test certificates to the Engineer in Charge for approval before bulk supply. The ceiling panels shall be from reputed manufacturer and of thickness as specified in the drawings.

ii) **Installation:**

Installation shall be strictly as per manufacturer's instructions. For E- Grid (exposed grid) ceilings systems, the grid size shall be either 600mm x 600mm or 1200mm x 600mm with main runner 38mm x 24mm, Cross Tee 29mm x 24mm & wall angles 24mm x 24mm. The ceiling panels shall be fixed in the E- Grid system using 4mm/ 6mm dia GI/ MS bar hanger fixed with steel dash fasteners or iron purlin from the roof with adjustment clip providing positions for light fixtures, air conditioning diffusers, ducts, sprinklers, smoke detectors, etc. The main runners to be secured to the structural soffit by hangers @ 1220mm maximum c/c. The last hangers at the end of each main runner shall be placed at more than 450mm from the adjacent wall. Flush fitting 1220mm Cross Tee to be interlocked between main runners @ 610mm c/c so as to form 600mm x 600mm/ 1200mm x 600mm grid. Where a flush surface is required, the joints finished to give a neat uniform surface, special care shall be taken to neatly finish the ceiling at junctions with wall, light fixtures diffusers etc..

10.5.10.4. Acceptance Criteria

~~Aluminium lineal ceiling shall comprise of plan panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll forged out of 0.5 mm thick aluminium alloy AL- Mg- 1.5 conforming to ASTM designation AA5050 stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the mould of 100 mm, at maximum 1.2 m c/c. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of springs steel max. 1.2 m c/c hangers fixed to roof by "J" hooks and nylon inserts. Bonded mineral wool blanket of thickness 25 mm shall be provided. Minimum coefficient for thermal conductivity (K) shall be 0.49 mw/cm deg. C (at 50 deg. C). Minimum density of the material shall be 48 kg/ m³ for rock wool and 32 kg/ m³ for glass wool. Insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.~~

Finished ceiling shall be at the correct plane and shall present a pleasing and uniform appearance, free from sags, warps, disfigured or damaged boards. Joints, exposed grid etc. shall be in true lines and symmetrically placed in a manner shown on drawings. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and at exact locations.

11. PAINTING AND ALLIED WORKS

11.1. Scope of Work

- i) This specification covers painting, wall finishing etc. of both interior and exterior surfaces of masonry, concrete, plaster, structural and other miscellaneous steel items, external surface of over ground water pipes, rain water down ~~com~~^mer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings or as directed by the Engineer-in-Charge.
- ii) If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the Contractor shall notify the Engineer-in-Charge in writing or assure responsibility for and rectify any unsatisfactory finishing that results.
- iii) Before commencing painting, finishing, the Contractor shall obtain the approval of the Engineer-in-Charge in writing regarding the scheduling of work to minimise damage, disfiguration or staining. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other installations.

11.2. Materials

- i) Materials shall be highest grade products of well-known approved manufacturer and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name, and colour shade, with labels intact and seal unbroken. All materials shall be subject to inspection and approval by the Engineer-in-Charge. It is desired that the materials of one manufacturer only shall be used as far as possible and paint of particular shade be obtained from the single batch. All paints shall be subjected to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer-in-Charge.
- ii) All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

- iii) All unspecified materials such as turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS Standards. All such materials shall be made by reputed and recognised manufacturers and shall be approved by the Engineer-in-Charge.
- iv) All colours shall be as per painting/finish schedule and tinting and matching shall be done to the satisfaction of the Engineer-in-Charge. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer-in-Charge.
 - a) Synthetic Enamel Paint shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with ageing. The paint shall conform to IS: 2932 (Latest Revision) and IS: 2933 (Latest Revision).~~✓~~
 - b) Waterproof Cement Paint shall be made from best quality white cement and lime resistant colours with accelerators, water-proofing agents and fungicides. The paint shall conform to IS: 5410 (Latest Revision).~~✓~~
 - c) Acrylic Emulsion Paint shall be water-based acrylic copolymer emulsion with rutile titanium dioxide with excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, should be able to withstand washing with mild soap and water without any deterioration in colour or without showing flaking, blistering or peeling.~~✓~~
- v) Storage:

The contractor shall arrange for safe and proper storage of all materials and tools. Paints shall be kept covered at all times, and mixing shall be done in suitable containers. All necessary precautions shall be taken by the Contractor against fire hazards.

11.3. Preparation of Surface

i) General:

Before starting the work, the Contractor shall obtain the approval of the Engineer-in-Charge regarding the soundness and readiness of the surface to be painted on.

ii) Masonry, Concrete and Plastered Surface:

Surface shall be free from oil, grease, efflorescence, loose paint or other foreign and loose materials. Masonry cracks shall be cleared out and patch filled with mortar similar to the original and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaced area shall be treated with minimum one coat of cement ~~primer which~~primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

iii) Surface with mildew and efflorescence shall be treated as below:-

- a) All mildew surfaces shall be treated with an approved fungicide such as ammonical wash consisting of 7 ~~g~~g of copper carbonate dissolved in 80 ml liquid ammonia and diluted to 1 litre with water, or 2.5 per cent magnesium silico fluoride solution and allowed to dry thoroughly before paint is applied.
- b) All efflorescence shall be removed from affected surfaces with a solution of muriatic acid in water (1:6 to 1:8), washed fully with clear water and allowed to dry thoroughly.

iv) Prior to application of Primer coat, all the concrete/ plastered walls shall be covered with two coats of JK white putty after completing the aforesaid surface preparation works with the help of emery stone, putty blade or wire brush and moistening the wall with sufficient quantity of clean water as specified and directed by the Engineer-in-Charge. Total thickness of the Putty Coat is 1.5mm (maximum).

v) Prior to application of the paint of required shade, one coat of water thinnable priming coat with cement primer shall be applied on all the all the concrete/ plastered walls.

vi) Metal Surface:

All metal surfaces shall be absolutely clean, dry and free from wax, grease and soap films. All steel and iron surfaces in addition shall be free from rust. All galvanised iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

11.4. Application

i) General:

- a) The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size of 1

metre square as per instruction of the Engineer-in-Charge and obtain his approval prior to application of finishing paints. Proper tools and equipment shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes.

- b) Painting shall be done by skilled labours in a workman like manner. All materials shall be evenly applied, so as to be free of sags, run crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paints. All priming undercoats for painting shall be applied by brush only, and rollers, spray equipment etc. shall not be used.
- c) No work shall be done under conditions that are ~~unsuitable~~ for production of good results. No painting shall be done when plastering is in progress or is drying.
- d) All coats shall be thoroughly dry before being sand papered or before the succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so directed by the Engineer-in-Charge.
- e) Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

ii) **Synthetic Enamel Paint:**

Shall be applied on properly primed surface. Subsequent coat shall not be applied till the previous coat is dry. The previous coat shall be lightly sand papered for better adhesion of subsequent coats.

iii) **Waterproof Cement Paint:**

- a) Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours), the second coat shall be applied.

- b) In a similar manner the finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

iv) **Acrylic Emulsion Paint:**

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer-in-Charge. Painting shall be strictly as per manufacturer's specification.

11.5. Painting of ~~Structural / Miscellaneous Steel~~ Metal Work

- i) This specification covers painting of ~~the structural/miscellaneous steel~~ metal works supplied and erected either by other agencies or by the Contractor for work under the scope of this contract ~~as far as these work is not already covered under the section Metalwork, Surface Finish and Corrosion Protection.~~ One shop coat of red oxide zinc chromate primer including necessary touching up has already been completed. One coat of red oxide zinc finishing coats of synthetic enamel paint as described hereunder are only required to be provided under the item for painting ~~structural/miscellaneous~~ steel.
- ii) Painting shall be done on all exposed surfaces of ~~metal works structural members~~ (including undersides wherever exposed) of various structural steel members as directed by the Engineer-in-Charge. The scope of work shall account for all aspects involved in painting keeping in view the heights, available access to members etc. It is advised that the Contractor should visit the site and get himself acquainted with the nature of work completely including the extent and type of scaffoldings etc. required.
- iii) **Material:**
Paint shall be synthetic enamel paint conforming to IS-~~2932~~: 2932 (Latest Revision) of approved colour and brand.
- iv) **Painting:**
 - a) In general, painting work shall be in accordance with IS: 1477 (Part I & II) (Latest Revision).~~;~~
 - b) Surface of steel work to be painted shall be thoroughly cleaned of all grease, oil, dirt, rust, foreign matter like cement splashing, etc. by suitable solvent and mild rubbing with abrasive paper/hand scrapping to the full satisfaction of the Engineer-in-Charge. Cleaning with solvents/scraping shall be limited to the affected area only.~~;~~

- c) In case where the existing primer is removed while cleaning the surface ~~as detailed in 12.6 CHECK~~ damaged portions shall be provided with a coat of wash or etching primer on suitable chemical pre-treatment solutions and another coat of red oxide, zinc chromate primer.
- d) After the surface is prepared in a manner described above, the primer coat shall be dry cut without scratching or in any way damaging the primer coats and clean the surfaces from dust.
- e) Over this dry surface apply an optimum coat of undercoating (synthetic enamel paint) by spray with minimum brush marks. Allow the film to dry hard, wet rub, cutting down to a smooth finish (ensuring that at no place the undercoat is completely removed). Allow the water to evaporate.
- f) Finishing coats shall consist of two coats of synthetic enamel paint of approved colour and brand. The second coat, if so directed by Engineer-in-Charge, shall be applied only after the first coat is hard dry, its gloss is gently removed over the entire surface and dusted off.
- g) The total dry film thickness of each shall be not less than 25 microns.
- h) The paint shall be applied by brushing/spraying. Spraying shall be adopted with prior approval of Engineer-in-Charge generally on large surface areas. Paints shall be stirred frequently to keep the pigment in suspension. Paint shall be ready mixed in original sealed containers as packed by the paint manufacturers and no thinners shall be permitted. No painting shall be done in frosty/foggy rainy weather or when humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be paint is 5°C or lower.
- i) Contractor shall provide and use sufficient ~~number of drop~~ number of drops clothes, covers, ~~tarpantins~~ tarpaulins and other screens to protect adjacent surfaces and shall remove all splatter and stains from such surfaces. The Contractor shall also protect his own work.
- j) Any and all damage to adjacent work or any part of the premises due to painting carelessness or accidental performance of the Contractor shall be repaired or made good at the Contractor's expense.

- k) Painting shall be discontinued when exposed to rain and dust storm and shall not commence until the surfaces are perfectly dry and clean. Wherever practicable, surfaces shall be painted when Urban-under shade or when temperature is falling.

11.6. Protection

~~11.7. Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of all painting work. All stationary items of equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protection shall be as per instruction of the Engineer in-Charge.~~

11.8. Cleaning Up

~~11.9. The Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings, etc. to the satisfaction of the Engineer in-Charge.~~

11.10-11.6. Acceptance Criteria

- i) All painted surfaces shall be uniform and pleasing in appearance.
- ii) The colour, texture, etc. shall match exactly with approved samples.
- iii) All stains, splashes and splatters of paint shall be removed from surrounding surfaces

12. DESIGN, MANUFACTURE, TRANSPORTATION, ASSEMBLY, INSTALLATION & COMMISSIONING OF PRE- ENGINEERED BUILDING

12.1. Intent of Specification

The intent of this specification is to establish the minimum requirement of design & engineering, design certification, selection, manufacture, assembly, inspection, shop testing, shop painting, delivery FOR site properly packed for transportation suitably protected from weather including transit insurance of all materials, unloading at site, transportation to stores, safe storage at site, insurance against pilferage, transportation from stores to site, final painting, erection, testing, final handling over as mentioned hereinafter for the Pre Engineered Buildings (PEB), which form part of project.

It is not the intent to completely specify all details of design, manufacture and construction. Nevertheless the installations shall conform to high standard of engineering/

quality and shall be capable of serving the intended purpose in a manner acceptable to the owner (NEEPCO).

12.2. Bidder's Scope of Services

List of major services included in bidder's scope:

- Detailed Engineering and obtain approval of the same from NEEPCO before start of the work
- Engineering for Procurement.
- Bill of Materials
- Ordering of all material.
- Overall Project Management and progress reporting to owner.
- Expediting suppliers and sub vendors.
- Procurement
- Manufacture, fabrication and assembly at works and site.
- Inspection and testing.
- Painting at works, painting at site including touch up paint.
- Dispatch and transportation of materials, consumables, construction aids etc. to site.
- Establishment of site office complete with all facilities and communication network, as required.
- Storage, loading, unloading, security and handling at site.
- Construction at site including fabrication, erection and installation. Supervision of work during fixation of foundation bolts. Grouting, alignment and necessary activities for installation of complete PEB buildings.
- Site clearing and cleaning.
- Liaisoning with other contractors in the plant, if any.
- Handing over the PEB Building to the owner.
- Supply of all test reports / certificates.
- Providing as built drawings to the owner.

Bidder to note that the above list is not exhaustive and any other service required as per the intent of this specification/ project requirements/ good engineering practice shall be deemed to be included in bidder's scope without any commercial implication to the owner.

12.3. Design Specification

12.3.1. Detailed Scope of Work

Preparation of design and drawing of the following building components:

Steel Portal Frames including rafter bracings with the rod and pipe, column bracings, portal bracings, gable end columns, purlin, girt, eave strut, sag rod, gutters, base plates, gusset plates, anchor bolts, canopy, framed opening for rolling shutter / door, walk way, handrail, foundation, pedestal, tie beam, etc.

Any other requirement for the commissioning of the building in all respects in accordance with the provisions of the Contract and/or to ensure the structural stability and safety during and after construction.

12.3.2. Detailed Engineering

The contractor shall design the structures and prepare all the required drawings needed for correct and accurate construction. The design shall be strictly in accordance with the "*Design Specifications*" given in **Section – A**.

The contractor shall submit the design basis and General Arrangement (G.A) of the structure along with required explanatory sketches/ drawings and get the same reviewed by NEEPCO before starting the final design and Good for Construction (GFC) drawings.

Construction of the structure shall not be taken up at site till all the drawings are reviewed by NEEPCO and comments/ suggestions given by NEEPCO are incorporated.

NEEPCO reserves the right to review any/ all or none of the designs and drawings. Review by NEEPCO shall not relieve the contractor of his responsibility for correct design and execution of the works.

The final design and GFC drawings shall directly adhere to the reviewed design basis and general arrangement and shall incorporate all the comments/ suggestions given by NEEPCO without any extra cost to the Owner and any implication on time schedule for completion of work.

After the completion of erection and construction, the contractor shall submit to the Owner "As Built" drawings in 3 sets of copies as specified elsewhere.

12.3.3. Section A

The brief description of the building for the Proposed Project are as below:

Length	:	70.35m (External)
Width	:	20.0m (External)
Clear height	:	5.0m (upto Eave)
Roof slope	:	1 in 10 or as shown in the drawings
Bay Spacing	:	5.0m c/c or as per Tender Drawing
Roof	:	0.47mm TCT Standing seam profile Bare Galvalume/ Zinalum sheets for the Roof Single skin.
Wall cladding	:	0.5mm TCT Colour coated Galvalume/ Zinalum sheet for the walls above 900mm brick wall (full brick) along the periphery of the building.
Canopy	:	shall be placed in location of rolling shutter and fire exit door.
Framed openings	:	2 nos– 4.50m (B) X 4.50m (H) for rolling shutter, 1.0m (B) X 2.1m (H)
Opal white	:	2mm Poly carbonate sheets for sky lights: 5% of Roof Plan Area.

Eaves Gutter & Down take pipes: in Colour galvalume sheets.

12.3.4. Codes and Standards

Following codes and standards (latest editions) including their latest addenda shall be followed wherever applicable unless otherwise specified:

IS-875-I	:	Code of Practice for Design Dead Loads for Building and Structures
IS-875-II	:	Code of Practice for Design Imposed Loads for Building and Structures
IS-875-III	:	Code of practice for design loads (other than earthquake) for buildings and structures.

IS-1893	:	Criteria for earthquake resistant design of structures.
IS-4326	:	Code of Practice for earthquake resistant design and construction of buildings
IS-800	:	Code of practice for use of structural steel in general building construction
IS-801	:	Code of practice for use of cold-formed light gauge steel structure members
IS-806	:	Code of practice for use of steel tubes in general building construction
IS-808	:	Dimensions for hot rolled steel beam, column channel and angle section
IS-811	:	Specification for cold formed light gauge structural steel sections
IS-2062	:	Hot rolled medium and high tensile structural steel–specification
IS-4923	:	Hollow steel sections for structural use.
IS-1161	:	Steel tubes for structural purpose
IS -4736	:	Hot dip zinc coatings on mild steel tubes
IS -4759	:	Hot dip zinc coatings on structural steel and other allied products – specification
IS -2395 – I	:	Paintings of concrete, Masonry and plaster surfaces
SP- 6	:	Handbook for structural engineers (all parts)
IS -3600	:	Testing methods of fusion welded joints and weld metal in steel.
IS -3757	:	High strength structural bolts.
IS -4000	:	Code of practice for high strength bolts in steel structures
IS -5369	:	General Requirements for plain washers and lock washers
IS -5624	:	Foundation bolts.

IS -6227 : Code of practice for use of metal arc welding in tubular structures

IS -6623 : High strength structural nuts.

IS -6639 : Hexagonal bolts for steel structures.

12.3.5. Loading

12.3.5.1. General

The structure shall be designed for all loads, including the weight of structure, live load, wind or earthquake. Due consideration shall be given to loading during the construction / erection phase and accounted for in the design.

12.3.5.2. Design Loads:

Dead Load:

Self-Weight of Structure including Purlins, Sheeting, Girts, Bracings, etc. to be added as Dead load. etc.

Imposed Load (Live Loads):

Live loads shall be as per IS: 875. For sloped roofs up to 10 deg. it shall be 0.75 kN/m².

Wind Load:

Wind loads shall be as per IS: 875. The basic wind speed of the site is taken as 50.0 m/s. Values of coefficients K₁, K₂, K₃ shall be as K₁ = 1.0 for permanent structures. K₃ = 1.0, K₂ shall be taken for relevant class of the structure with Category 2 terrain with respect to the actual height of the structure. The design life span of all structures shall be taken as 50 years.

Earthquake Load:

Seismic forces shall be as per IS: 1893, ZONE-V as applicable to North East.

12.3.5.3. Vertical Deflection And Horizontal Sway Limits :

Limiting Deflection:

- (a) The limiting permissible vertical deflection for structural steel members shall be as specified below:

Structures/ structural components : as per IS: 800-2007 code.

- (b) The limiting permissible horizontal deflection for as per IS: 800-2007 code where 'h' is height of building at eaves

12.3.5.4. Frame Analysis :

The frame shall be analyzed with pinned base structure as given in the general arrangement drawings.

- (a) Loads as per clause 3.2 of IS : 800 -2007 and IS – 875
- (b) Design as per IS: 800 - 2007.
- (c) Loading combinations as per Clause 3.5 and Table 4 of IS: 800 - 2007.
- (d) Deflection both lateral & Vertical as per Table 6 of IS: 800 - 2007.
- (e) Design should be based on Limit State method.
- (f) Both Limit States of strength as well as serviceability should satisfy the performance requirements refer Clause 5.2.2.1 and 5.2.2.2 of IS: 800 – 2007.
- (g) Factors governing the ultimate strength as per clause 5.5. of IS: 800 - 2007 should be ensured.
- (h) Limit states of serviceability as per clause 5.6 of IS: 800 - 2007 should be ensured.
- (i) Method of analysis may be any one of the method prescribed as per clause 4.1 of IS: 800 - 2007.
- (j) Notional Horizontal loads as applicable, as per clause 4.3.6 of IS : 800 – 2007 should be applied on the structure and checked.
- (k) If Elastic analysis is carried out it should be based on 4.4 of IS: 800 - 2007.
- (l) Effective length of compression member should be as per clause 7.2 and maximum values of effective slenderness ratios should be as per Table 3 of IS: 800 - 2007.
- (m) Limiting width to thickness ratio of elements may be as per Table 2 of IS: 800 - 2007.
- (n) Transfer of Horizontal forces due to wind and EQ to the foundation should be ensured by proper means. Uplift due to wind and EQ should also be checked for beams and columns, purlins.
- (o) Expansion joint need not be given as per clause 3.10.3.2 of IS: 800 - 2007.
- (p) Columns should be treated as fixed at foundation level.
- (q) Erection loads to be taken in design.

- (r) For bolts nuts and washers reference to be made to clause 2.4 of IS: 800 - 2007.
- (s) Effective sectional area should be as per clause 7.3.2 of IS : 800 – 2007.
- (t) Gusseted column bases should be as per clause 7.4.2 of IS : 800 – 2007.
- (u) In the design laterally supported beams reference should be made to clause 8.3.4
Combined stresses refer clause 9.3 of IS: 800 - 2007.

12.4. Drawings :

- (a) The contractor shall develop and submit all 'Shop Drawings' and to obtain approval from the owner.
- (b) Revisions to drawings are likely to be made to reflect additional data, or, additional details defining updated requirements. Revisions to drawings and any new drawings made to include additional work for the Contractor shall be considered a part of this specification and contract. Extra claims by the contractor on this account shall not be entertained.
- (c) In case of variations in 'Drawings' and 'Specifications', the decision of the Engineer in charge shall be final and binding.
- (d) Contractor shall prepare all fabrication and erection drawings necessary for completing the work satisfactorily.
- (e) Drawings shall be of one standard size, and shall be clear and legible. Drawings shall be based on tender drawings supplied by the owner, but they shall verify actual clearances and dimensions from site on works executed by other agencies and from Engineer in charge.
- (f) Shop drawings shall include, but not be limited to:
 - Detailed marking plans.
 - Details member connections and connections to other structures and components of building.
 - Detailed dimensions for fabrication indicating dimensional modifications required for field conditions
 - Welding and bolting procedures to be used both at shop and field.
 - Cambers required to be provided, and permissible tolerances in fabrication.
 - Assembly and Erection sequences indicating components to be connected at field.

- Complete bill of materials for each component (preferably drawing wise.)
- (g) Before submitting of shop drawings and calculations to the Engineer in charge for approval, these shall be checked and certified by the contractors own structural Engineer.
- (h) If necessary and called for by the Engineer in charge, shop drawings shall be revised to suit modified requirements and these shall be resubmitted for approval of the Engineer in charge.
- (i) While the shop drawings prepared by the contractor, and approved by the Engineer in charge represent the correct interpretation of work to be done, the contractor is not relieved of his responsibilities for:
 - Dimensional accuracy
 - Correctness of engineering and design of connections
 - Fit of parts
 - Details
 - Errors or omissions
 - Material and workmanship
 - Methodology of fabrication and erection
 - Safety of performance

12.5. Submittals :

On commencement of the Project, the Contractor shall submit the following to the Engineer-in-Charge:

- (a) Prior to the technical submittals, the contractor shall submit detailed baseline program and methodology indicating the proposed overall schedule for documentation such as calculations, shop/working drawings, plan/procedures and records. Submission of samples, process of fabrication / delivery to site storage yard for the approval of the Engineer in charge.
- (b) Complete fabrication drawings, materials lists, cutting lists, bolt lists, welding schedules and QC schedules, based on the design drawing furnished to him and in accordance with the approved schedule. It is highlighted that structural steel members, dimensions thereof indicated in tender drawings of NEEPCO are tentative only, and may be modified during final design stage.

- (c) Results of any tests, as and when conducted and as required by the Engineer in charge.
- (d) Manufacturer's mill test reports in respect of steel materials, bolts, nuts and electrodes, wires as may be applicable.
- (e) A detailed list of all constructional Plant & Equipment, such as cranes, derricks, winches, welding sets etc. their makes, model, present condition and location, available to the contractor and the ones he will employ on the job to maintain the progress of work in accordance with the contract.
- (f) The total number of experienced personnel of each category, like fitters, welders, riggers etc., which he intends to deploy on the project.
- (g) The contractor shall submit complete design calculations for all the primary and secondary members like rafters, columns, purlins, sag rods, wall girt, cleats, portal bracing, rafter bracing etc.

12.6. Structure & Material Specification:

The go-down proposed to be constructed shall have a steel frame primary structural members. Primary members fabricated from plates shall conform to IS: 2062 min Grade E250 Quality BR/ ASTM A572-12 Grade 50 with minimum yield strength of 345 MPa. Minimum thickness of steel plates shall be 4 mm. Hot rolled primary structural members and Rod/ Angle bracing shall conform to IS: 2062 Grade E250 Quality A. Secondary members for Purlins and Girts shall conform to the specification of IS: 811 or ASTM A1003-12 made from steel sheets conforming to ASTM A1011-12b Grade 50 having a minimum yield strength of 345 MPa. The minimum thickness of secondary members shall be 2.55 mm. All other miscellaneous secondary members shall have minimum yield strength of 250 M Pa. Roofing shall consists of 0.47mm TCT Standing seam profile Bare galvalume/ Zinalum and wall cladding shall be of 0.5mm TCT Colour coated Galvalume/ Zinalum sheet for the walls above 900mm brick wall (full brick) along the periphery of the building. Wall cladding or roofings must CFC free, self-extinguishing, fire retardant type with density 40+/- 2 kg /m3 and thermal conductivity 0.019-2.2 W/(mK) at 10 deg C.

12.9.1. Roof Sheetting

Roof panels shall be made out of 26 gauge high tensile steel double lock standing seam profiled sheets having min. yield strength of 345 MPa conforming to ASTM-A607 with

galvalume coating to AZ-150 bare galvalume, as per ASTM A-792-AZ to make TCT of 0.47mm. The profile shall be trapezoidal shaped to satisfy the loading requirements or any other profile if proved to have sufficient strength to take DL, LL & wind loads, etc. or any other construction stage loading

12.9.2. Wall Cladding

Wall panel material specifications shall be same as roof panels. They shall be polyester coated of approved standard colour 0.5 TCT The profile shall have a maximum pitch of 200mm and minimum depth of 26 mm. Alternatively maximum pitch of 333mm with two intermediate stiffening ribs will be acceptable or any other profile if proved to have sufficient strength to take the relevant wind loads.

12.9.3. Fasteners and Connections

Special coated self - drilling screws/ fastener shall be used conforming to class 3 as per AS: 3566.1 and AS: 3566.2. Steel bolts, nuts and washers complying with AS 1112:2000. High Strength Bolts for Primary Connections IS: 1367 (Part III) Gr. 8.8 / ASTM A325. Bolts for Secondary Connection IS: 1367 (Part III) Gr. 4.6 / ASTM A307. Anchor/ foundation Bolts shall conform to IS: 5624 and relevant IS code.

The maximum spacing of the fastener shall be 390 mm c/c along the length of purlins / runners. However exact spacing shall be as per the design done by the bidder of the fastener considering the wind load, self-load and other associated load. Minimum diameter of the fastener shall be 5.5 mm and at least 3 nos. of fastener shall be used per sheet. Fillers blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The fillers blocks shall be manufactured from black synthetic rubber or any other material approved by engineer.

12.9.4. Site Connections

- (a) All primary bolted connections shall be provided with galvanized high strength bolts, washers, nuts conforming to specifications of grade 8.8 of IS : 1367
- (b) All secondary bolted connections shall be furnished with bolts, nuts, washers conforming to the specifications of grade 4.6 of IS 1367 or ASTMA307

12.9.5. Shop Connections

All shop connections shall be welded with appropriate arc welding process and welding shall be in accordance with IS: 816, IS: 819, IS: 1024, IS: 1261, IS: 1323, IS: 9595, as appropriate. The Webs should be welded on to the flanges at both the faces at top and bottom for columns, beams. Weld material should have strength more than the parent metal.

12.9.6. Sealer

This is to be applied at all side laps and end laps of roof panels and around self-flashing windows. Sealer shall be pressure sensitive elastomeric Butyl tapes. The sealer shall be non-asphaltic, non-shrinking and nontoxic and shall be superior adhesive metals, plastics and painted at temperatures from 51°C to +104°C.

12.9.7. Grouting

Cement mortar (1:2) grout with non - shrink additives shall be used for grouting below base plate of column. The grout shall be high strength grout having a minimum characteristic compressive strength of min 30 N/ mm² at 28 days.

12.9.8. Anchor Bolts

The bolt materials shall conform to IS: 2062 with minimum yield strength of 250 MPa. The lower end of the anchor bolt should be bent with a minimum radius of curvature of 3d (diameter of the bolts) or as per shop drawing. The upper exposed portion of the bolt should have min threaded portion of 115 mm (min) with one hexagonal nut followed one hexagonal lock nut. Suitable Plate washers should be provided along with the anchor bolts.

12.9.9. Flashing:

Ridge flashing shall be trapezoidal matching the roof profile and bent to the ridge angle. All the other flashing to be manufactured out of the same material and thickness as that of roofing, Wherever the flashing interface with trapezoidal profile roofing, filler blocks should be provided in the gaps and sealed with silicon sealant for leak proof performance. After the installation the roof should be cleared of all the metal wastes, screws, nails etc. Necessary profiled filler should be provided at the higher level of roof sheeting & also at the valley gutter in order to ensure water tightness in the profile gaps. All external flashing in

the roof all around excluding gutter are to be of the same material and thickness as roof sheeting.

12.9.10. Gutter and Downpipe:

Gutter shall be manufactured out of 3.0 mm thick Plain GI sheets in lengths of 2.5 - 3 m min. (Longer lengths preferred). All the gutter joints shall be fixed by bulb tight rivets and silicon sealant shall be applied all over the joint for leak proof performance. The gutter end caps shall be provided at either ends and duly sealed with silicon sealant. The opening shall be made in the gutter for down spot position with sleeves fixed on the gutter and connecting the down take pipe. Silicon sealant to be applied all over the joints to ensure water tightness. The gutter slope shall be in such a way that the water collected from the roof move on the down take pipe smoothly without stagnation of water at any point of the gutter. Size & Shape of the gutter will be trapezoidal section of min. 350mm x 300mm with min. 200 mm depth for effective drainage of the storm water depending upon the rainfall to be designed by the supplier and approved by NEEPCO. The Gutter openings at the top of the water down pipe should be provided with suitable MS wire mesh to prevent the entry of foreign materials like dry leaves, polythene bags etc. and choke the water down pipe/drains. For effective drainage of storm water, the down pipe will be heavy duty PVC drain pipe of 160mm square size running along the surface of wall cladding. Cost of clamp, brackets and accessories etc. to be included. Gutter to be tested with water filled for 24 hrs. to ensure it is water tight.

12.9.11. Fascia:

Provision to be made for fixing 800mm wide fascia to be provided all along with the canopy sides. MS Fascia sheet of 2mm to be fixed along with the frame on all sides. The weight of the fascia on the front, rear and sides to be considered while designing canopy.

12.7. Handling and Storage:

- (a) Proper storage of steel (sections and fabricated members) at the job site shall be the responsibility of the Contractor.
- (b) Structural steel shall be stored out of mud and dirt. Proper drainage of the storage area shall be provided. These shall be protected from damage or soiling by adjacent construction operations.

- (c) Fabricated steel shall not be handled until the paint has thoroughly dried. Care shall be taken to avoid paint abrasions and other damage. Steel work shall be transported in such a way so as not to over stress the fabricated sections. All pieces bent or otherwise damaged shall be rejected and shall be replaced by the contractor at his own cost.
- (d) Checking and inspection of fabricated structural steel work by the Engineer in charge shall be done at various stages of completion of fabrication work. The contractor is required to ensure that fabricated steel work is properly stacked such that all joints of all members are either visible or accessible for inspection at all stages of inspection work. Care should also be taken to ensure that fabricated members are not subjected to stresses due to defective stacking.

12.8. Fabrication:

- (a) All fabrication work shall be done in accordance with IS: 800: 2007 read in conjunction with relevant codes mentioned therein.
- (b) Fabrication shall be done in workshops approved by Engineer in charge, unless specifically permitted by Engineer in charge that fabrication can be done at site. Under such circumstances work shall be done on a specially designed and constructed platform. Location, size, specification and construction of such a platform shall have prior approval of Engineer in charge. Loads associated with such platforms shall be provided to Engineer in charge.
- (c) Mild steel rolled sections and plates shall be cut by shearing/machining and grinding the surfaces to true sizes and shapes. Gas cutting of mild steel may be permitted by the Engineer in charge, provided that every cut face and edge is smoothed by grinding operation. Prior approval of Engineer in charge must be obtained for using gas-cutting techniques either by mechanized gas cutters or manually operated gas cutters. While, using gas-cutting methods, proper allowance must be made for grinding to bring the cut piece to exact required dimensions.
- (d) Extensive use of templates shall be made in doing fabrication work. Templates shall be clean and should have true surfaces prepared for every successive use. Reinforcements for the structural steel members if required shall be included. In

case actual members are used as templates for similar pieces are fit to be incorporated in the finished structure. Jigs and manipulators shall be used, where practicable, and shall be designed to facilitate welding and to ensure that all welds are easily accessible to the operators.

- (e) All material shall be straight and free from twist and bends unless required to be curvilinear in form. If necessary the material shall be straightened and / or flattened/straightened by pressure. Heating of rolled sections and plates for purpose of straightening shall not be permitted.
- (f) Curvilinear members shall be formed by bending with the help of pneumatic press. Final shaping, to a very limited extent, however, may be done by local heat application. This shall be done only on receiving approval from the Engineer in charge.

12.9. Welding:

General

- (a) In general, only Automatic submerged arc welding will be used for fabrication. Subject to approval of Engineer in charge, Metal inert gas welding may be done for short length where access to the location of the weld does not permit submerged arc welding. The welding and the welded work shall conform to IS: 816, unless otherwise specified. As much work as possible shall be welded in shops and the layout and sequence of operations shall be so arranged as to eliminate distortion and shrinkage stresses. Unless otherwise specified all weld shall be for full contact for all sides.
- (b) Electrodes for shielded-arc manual welds shall comply with the requirements of IS: 814 and shall be amenable to radiographic tests and shall be of approved make. The electrodes for manual arc welding shall be suitable for use in the position and type of work, as laid down in the above specifications and as recommended by the manufacturers. Electrodes classification group 1 or 2 as given in IS: 814 shall be used for welding steel conforming to IS: 2062. Electrodes shall conform to IS-1442 for steel conforming to IS: 8500. Joints in materials above 20mm thick, and, all important connections shall be made with low hydrogen electrodes. Electrode flux covering shall be sound and unbroken. Broken or

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

- (c) Electrodes larger than 5mm diameter shall not be used for root-runs in butt-welds. Welding plant and accessories shall have capacity adequate for the welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality, the Contractor shall maintain all welding plant in good working condition. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided.

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

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

- (d) Fusion faces and surfaces adjacent to the joint for a distance of at least 50mm on either side shall be absolutely free from grease, paint loose scales, moisture or any other substance which might interfere with welding or adversely affect the quality of the weld. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations etc. Preparation of fusion faces shall be done in accordance with the approved fabrication drawings by shearing, chipping, machining or machine flame cutting except that shearing shall not be used for thickness over 8mm

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

- (f) Members to be joined by fillet welding shall be brought and held a close together as possible and in no event shall be separated by more than 3mm. If the separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation. This shall only apply in the case of continuous welds. The fit-up of joints at contact surfaces which are not completely sealed by welds shall be close enough to exclude water after painting.
- (g) The separation between fraying surfaces of lap joints and butt joints with backing plate shall not exceed 1.5mm. Abutting parts to be butt welded shall be carefully aligned and the correct root gap maintained throughout the welding operation. Misalignments greater than 25 percent of the thickness of the thinner plate or 3mm whichever is smaller shall be corrected and in making the correction the parts shall not be drawn into a slope sharper than 2 degrees.
- (h) Welding procedures recommended by appropriate welding standards and known to provide satisfactory welds shall be followed. A welding procedure shall be prepared by the Contractor and submitted to the Engineer in charge for approval before start of welding.
- (i) Approval of the welding procedure by the Engineer in charge shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.
- (j) No Welding shall be done when the surface of the members is wet, not during periods of high wind unless the welding operator and the work are properly protected. In joints connected by fillet welds, the minimum sizes of single run fillet welds or first runs and minimum full sizes of fillet welds shall conform to the requirements of IS : 816 and IS : 823, Fillet welds larger than 8mm shall be made with two or more passes.
- (k) All 'full penetration butt welds' made by manual arc-welding, except when produced with the aid of backing material or welded in flat position, from both sides in square-edge material, not over 8mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and

shall be so welded as to secure sound metal and complete fusion throughout the entire cross section.

- (l) Butt welds shall be terminated at the ends of a joint in a manner that will ensure their soundness where abutting parts are 20mm or more in thickness, run-on and run-off plates with similar edge preparation end having a width not less than the thickness of the thicker part joined shall be used. These extension pieces shall be removed upon completion of the weld and the ends of the weld made smooth and flush with the abutting parts. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the ends of the butt welds shall then be chipped or gouged out to sound metal and side welded to fill up the ends to the required reinforcement.
- (m) Each layer of a multiple layer weld except root and surface runs may be moderately peeled with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peeling.
- (n) Before commencing fabricating of a member or structure in which welding is likely to result in distortion and/or locked up stresses, a complete programme of fabrication, assembly and welding shall be made and submitted to the Engineer in charge for his approval. Such a programme shall, include, besides other appropriate details, full particulars in regard to the following:
- Proposed pre-bending of components such as flanges and presetting of joints to offset expected distortion.
 - Make up of sub-assemblies proposed to be welded before incorporation in final assembly.
 - Proposed joint forms, classification of wire and flux or covered electrodes, welding process including fitting and welding sequence with directions in which freedom of movement is to be allowed.
 - Proposed number, spacing and type of strong details of jigs and fixtures for maintaining proper fit up and alignment during welding.
 - Any other special features like assembling similar members back to back or stress relief.

12.9.1. Inspection of Welds

- (a) All welds shall be inspected for flaws as per IS: 822. The choice of the method to be adopted, shall be determined by the Engineer in charge.
- (b) The contractor shall arrange for all tests as called for, at his own cost.
- (c) In case the tests uncover defective work, such tests shall be at the Contractor's cost and the Contractor shall correct such defects at his own cost and prove the soundness of rectified work.
- (d) The correction of defective welds shall be carried out as directed by the Engineer in charge without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Engineer in charge shall be used to ensure that the whole of the crack and material up to 25mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the Contractor's account.

12.10. Fabrication Tolerances

Unless otherwise shown on drawings, the fabrication tolerances shall generally be as detailed hereunder.

(a) Straightness :

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel and equivalent applicable codes for imported steel. The acceptable limits for straightness (sweep and camber) for rolled or fabricated members shall be:-

Struts and columns: $L/1000$ or 10mm whichever is smaller. For all other members not primarily in compression such as purlins, beams, bracings & web members of trusses and latticed girders: $L/500$ or 15mm whichever is less. (Where L is the length of finished member, or such lesser length as the Engineer in charge may specify).

(b) Twists :

A limit of twist (prior to erection) in:

- Box girders and heavy columns: $L/1500$
- Other members $L/1000$

(c) Camber :

Tolerance in specified camber of structural members shall be $\pm 3\text{mm}$

(d) Length :

Tolerance in specified length shall be as follows:-

Type of member	Tolerance
A column finished for contact bearing	: $\pm 1\text{ mm}$
Other members (e.g. beams) under 10 m	: + 0 and -3mm
Other members (e.g. beams) 10 m long and over	: + 0 and -5mm

(e) Butt Joints :

For full bearing, two abutting ends of columns shall first be aligned to within 1 in 1000 of their combined length and then the following conditions shall be met:

- Over at least 80% of the bearing surface the clearance between the surfaces does not exceed 0.10mm.
- Over the remainder of the surfaces the clearance between the surfaces does not exceed 0.30mm.

Where web stiffeners are designed for full bearing on either the top flange or bottom flange or both, at least half the stiffener shall be in positive contact with the flange. The remainder of the contact face could have a max. gap of 0.25mm.

(f) Depth of Member :

Acceptable deviation from the specified overall depth is:

- For depths of 900 mm and under : $\pm 3\text{mm}$.
- For depths over 900 mm and under 1800mm : $\pm 5\text{mm}$
- For depths of 1800 mm and over : +8 mm - 5mm

(g) Web Plates :

Acceptable deviation from flatness in girder webs in the length between the stiffeners or in a length equal to the girder depth shall be $1/150^{\text{th}}$ of the total web depth.

(h) Flange Plates :

- Limit for combined warp-age and tilt on the flanges of a built up member is $1/200$ of the total width of flange or 1.5 mm whichever is smaller measured with respect to centre line of flange.

- Lateral deviation between centre line of web plate and centre line of flange plate at contact surfaces, in the case of built up sections shall not exceed 3 mm.

12.11. Inspection

- (a) The contractor shall give due notice to the Engineer in charge in advance if the materials or workmanship getting ready for inspection.
- (b) All rejected material shall be promptly removed from the shop and replaced with new material for the Engineer in charge's approval / inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the Engineer in charge, if it fails to be in proper conditioner has fabrication in accuracies which prevents proper assembly. No materials shall be painted or dispatched to site without inspection and approval by the Engineer in charge unless, such inspection is waived in writing by the Engineer in charge.
- (c) Shop inspection by the Engineer in charge or his authorized representative, or submission of test certificates and acceptance thereof by the Engineer, shall not relieve the Contractor from the responsibility of furnishing material conforming to the requirements of these specifications. Nor shall it invalidate any claim, which the Engineer in charge may make because of defective or unsatisfactory material and/or workmanship.
- (d) The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the Engineer in charge.

12.12. Testing

(a) Material Testing

If mill test reports are not available for any steel materials, the same shall be got tested by the contractor to the satisfaction of Engineer in charge to demonstrate conformity with the relevant specification.

(b) Test on Welding

Magnetic Particle Test

Only where the Engineer in charge requires that flaw-detection of welds be done by 'magnetic particle test', in such cases the tests are to be done in accordance with IS: 3703. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the explicit written permission of the Engineer in charge.

Dye Penetration Test

Where welds are required to be examined by dye penetration inspection method, such tests shall be carried out in accordance with IS: 3658.

Radiographic Inspection

Whether instructed by Engineer in charge, or not, all 'Butt' welds shall be inspected by radiographic examination method. Such examination shall be done in accordance with the recommendations of IS: 1182.

12.13. Marking of Members

- (a) After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20mm high and to such optimum depth as to be clearly visible, even after a member is galvanized.
- (b) All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt-holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location. Erection marks on like pieces shall be at identical location. Members having lengths of 7.0m or more shall have the erection mark at both ends.
- (c) Each fabricated member, whether assembled prior dispatch or not so assembled, shall bear an erection mark, which will help to identify the member and its position in respect of the whole structure, to facilitate re-erection at site. This erection mark shall be incorporated in the shop detail and erection drawings.

13. Measurement and Payment

The payment shall be made at per unit area in SQM and measured upto second place of decimal. The measured area shall be the outside to outside dimension of the Go-down. The quoted rate shall include all the items required for successful completion of the building in all respect. No separate payment shall be made for any individual items. The contractor shall include all the services including Design & Engineering, procurement, supply, transportation, storage, testing, erection, related civil works, all men & machineries or any other services required for successful completion of the structure.

Warranty

The tenderer shall furnish Guarantees for;

(a) Roof: 10 years for leak proof ness.

(b) Frames: 20 years for structural integrity certificate. Written assurance in standard format shall be obtained from the contractor.

-----End of the Specification-----