

TENDER SPECIFICATION

BHEL PSSR SCT 1348

**GENERAL CIVIL WORKS FOR MAIN PLANT AND
AUXILLARY PLANT BUILDINGS**

FOR

2 X 600 MW TPP

FOR

TAMIL NADU ELECTRICITY BOARD

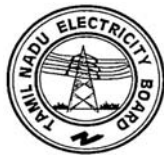
ATHIPATTU, TAMIL NADU

VOLUME – II BOOK 1

**TECHNICAL SPECIFICATION
BOOK NO ...**



**BHARAT HEAVY ELECTRICALS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
POWER SECTOR – SOUTHERN REGION 690,ANNA
SALAI, NANDANAM, CHENNAI – 600 035**



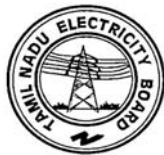
POWERING TAMIL NADU'S PROGRESS...

Specification No:SE/E/T&H(P)/No.175 / 2007-2008
Volume-V: Technical Specification-Civil

Section C3

TECHNICAL SPECIFICATIONS

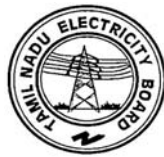
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3 EARTHWORK AND ROCKWORK

3.1 General

This section applies to all earth and rockwork required for the construction of buildings, any types of structure and burying service lines in the ground.

The contractor shall satisfy himself as to the ground conditions on the site including the nature of the strata to be excavated, obstructions, possibilities of flooding and such like and shall allow for all provisions necessary to carry out the work in the most suitable manner when submitting his tender.

Generally, all buildings and structures must be founded on bearing strata which means that all excavation work for foundations shall meet the requirements of structural analysis based on the results obtained from the soil investigation and of the available information and instruction given in writing by the Owner.

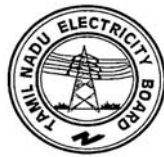
Furthermore, this division applies to excavation works in connection with pavement, roadwork and landscaping as far as earth and rockwork is concerned and deals with the handling and disposal of the materials to be re-used or taken to soil dumps on or off site.

Excavation shall be done to the required dimensions and shall be finished according to the specified lines and slopes, in a way acceptable to the Owner. All necessary precautions shall be taken to cause the minimum possible alteration or disturbance to the material lying under and adjacent to the excavation final lines.

3.2 Standards

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter.

IS:1498	Classification and identification of soils for general engineering purpose.
IS:2720	Method of test for soils (All Parts).
IS:3764	Excavation works – Code of safety.
IS:4081	Safety code for blasting and related drilling operations
IS:7293	Safety code for working with construction machinery.
IS:9759	Guideline for de-watering during construction.
IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and subgrade.



3.3 Fill materials

The fill materials used and source are to be examined and approved. Excavation materials can be used if they fulfill the requirements.

Select fill: Select fill shall have the following properties:

Well graded (uniformity index not less than 5), non-cohesive and nearly silt free (silt content not greater than 5%; up to 10% tolerated, except below footings of structures), salt free (content less than 3%), soils free of organic matter (limit 2%). Decomposing or compressible materials shall not be used.

All materials shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time. It shall be free of highly plastic clays, of all materials subject to decay, decomposition or dissolution, and of cinders or other materials which will corrode piping or other metal.

The intention is to use select fill below plinth, floors, roads, parking areas etc.

Ordinary fill: Ordinary fill shall have the following properties:

- i) Natural inorganic soils: salt content not greater than 5%, organic matter less than 3%. For other properties see under 'Select fill'.
- ii) The intention is to use ordinary fill for non-built areas.

Special fill: Special fill material shall be gravel or crushed rock (for other properties see under 'Select fill'). The intention is to use special fill e.g. as sub-base material for tanks and roads.

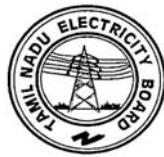
Rip-rap/Rockfill: Rip-rap must be of a size suitable for the place where it is to be used, as determined by the speed of the current, wave height and depth of water. Rip-rap shall be of deformable and yielding construction, using round stones if the intention is to safeguard the underlying ground against scour. If the rock infill is to be used as a foundation for structural components, the aim should be to secure effective bedding of angular stones under water. The stones must be weather and waterproof.

3.4 Excavation

The works shall be excavated either by hand or by use of excavating plant and tools acceptable to the Owner.

Excavation by hand may be required close to existing installations and/or underground services, but subject to special instruction of the Owner.

The contractor shall carry out all kind of earth and rockwork for the following particular works as defined hereafter (where applicable):-



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- i) Clearing and grubbing
- ii) Excavation of top soil
- iii) Open cut excavation
- iv) Backfilling
- v) safety precaution during earthwork
- vi) mining or underground excavation (if required)
- vii) Grading
- viii) Replacement of material
- ix) Trench excavation for service lines
- x) Embankments
- xi) Archaeological findings

3.4.1 **Safety precaution**

The contractor shall be responsible for all necessary safety measures.

Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides etc shall be to the Contractor's debit. The additional moving of soil resulting from such damages will not be paid for.

3.4.2 **over excavation**

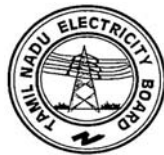
If somewhere, and for any reason, excavation are executed beyond the established design level, the contractor shall at his own expenses backfill with lean concrete to Owner's approval, the volume corresponding to over-excavation. He shall not receive payment for over-excavation not ordered.

3.5 **Stockpiles and disposal**

Excavated material from the works selected by the Owner for re-use shall be placed immediately in its final position, if possible, or otherwise may be stockpiled or deposited on site as directed by the Owner.

The contractor shall not have the right either to additional payment or to claim because of work involved in stockpiling materials, re-use of for carting to the waste disposal areas. Soil unfit for re-use shall be removed to sites approved by the Purchaser and shall not be permanently deposited elsewhere. The contractor shall trim and form the edges of spoil to profiles and levels as directed by the Owner.

The placing of materials within the waste disposal areas shall be made in layers not exceeding 0.50 m in thickness in order to obtain an appreciable degree of



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compaction by means of transportation equipment and/or if required by appropriate compaction equipment.

All traffic to or from the waste disposal areas shall run over the surface of such areas in order to achieve compaction.

3.6 Preparation of foundations

All rock surfaces on which or against which concrete is to be poured shall be carefully cleaned and roughened to the Owner's satisfaction.

The rock surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material. Rock faults, depressions and fractures shall be cleaned to a depth equal to their widths and to sound rock at both sides. Immediately before concrete placing, all rock surfaces shall be thoroughly cleaned by means of air and water jets, wire brushes, sand jets or by any other devices necessary to clean the foundation and keep it free of water, but shall be moistened prior to placing concrete.

All earth surfaces against which concrete are to be poured, shall be clean and free of any detrimental impurities, organic matter or unsuitable material. Immediately after excavation, all such surfaces shall be moistened and treated as directed by the Owner and then protected by means of a lean concrete layer, 7.5 cm or PCC thickness as shown in the design drawings, whichever is greater. No concrete is to be poured until formation is inspected and approved by the Owner.

3.7 Backfilling

Foundations and structures shall be backfilled as shown on the drawings with approved material compacted in layers not exceeding 150 mm by suitable equipment until optimum stability has been obtained to the satisfaction of the Owner. Compacting shall be carried out with special care by means of pneumatic or mechanical rollers or other compactors of a type previously approved by the Owner.

Density requirements as per standard Proctor Test shall be in accordance with relevant parts of IS: 2720 and all tests shall be made by/on under the supervision of Purchaser at contractor's own expenses, at optimum moisture content:-

a)	Backfilling of foundations and under grade slabs	- 98%
b)	Under roadways and parking areas	- 95%
c)	Embankment	- 95%

The thickness of fill layers, number of passes and type of equipment to be used shall be proposed to the Owner after compaction tests have been made.

Surfaces receiving fill layers shall, if smooth, be previously scarified to obtain a good key between the new fill layer and the subgrade.



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Backfilling of foundation work with approved materials shall be carried out only after foundations have been inspected by the Owner.

3.8 Soil replacement

The material to be used for replacement of soil shall not contain soluble or swelling components such as clays, or organic matters. Sand gravel mixtures of favourable grain size distribution shall be used in exchange.

Prior to the commencement of work, three samples shall be taken from the anticipated borrow area and tested in respect of IS:2720 or Proctor density, optimum moisture content, grain size distribution and content of soluble matters.

These three samples shall cover the approximate variation of materials to be expected within the borrow area.

The fill material shall be placed in horizontal layers of not more than 15 cm in compacted thickness. The fill moisture content shall be controlled and adjusted in order to achieve a maximum of compaction. Fresh water shall be used for watering of soils.

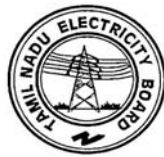
The fill material shall be compacted by vibratory roller (min. weight 20T.). The minimum required degree of compaction shall be as defined under "Tests and Properties". One Proctor and three density tests shall be made at every fourth fill layer prior to continuation of filling work. The testing location will be indicated by the Owner. The contractor shall either provide all required laboratory facilities and staff to perform the tests or he shall co-operate with an experienced soil testing laboratory, subject to the approval of the Owner.

The results of the tests shall be made available to the Owner within 24 hours of the tests. Filling work may be continued in case all tests performed show satisfactory results.

3.9 Groynes existing pipework etc.

If any existing works: groynes, buried pipes, pipe and cable ducts, wattle-work, fascines and the like interfere with the excavation profiles, irrespective of whether or not such structures are described in this Tender, these works shall be replaced with the approval of the Owner.

Any stored materials, such as pipes, fittings, accessories of assorted sizes or any other material obstructing the progress of work shall be reshifted by careful handling, loading, transporting, stacking and protecting. The contractor will be held responsible and liable for damage caused by him. Any such works shall be included in the lump sum.



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3.9.1 Pipe bed preparation

Pipe beds shall be constructed to guarantee the uniform transmission of loads. The bearing section for supported profiles shall cover at least an arc of 90°.

Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template supported at the desired grade, to fit the lower part of the pipe exterior.

Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than one quarter of outside pipe diameter with a minimum allowable thickness of 20 cm if not otherwise specified.

Where a firm foundation is not possible at the grade established due to soft, spongy or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected materials as approved by the Owner, properly compacted to provide adequate support for the pipe.

3.10 Blasting

The contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosives as per Explosives Rules 1940, corrected up-to-date.

Explosives used for blasting shall be stored in clean, dry, well ventilated magazines to be built for the purpose. Fuses and detonators shall be stored in separate magazines. Detonators and explosives shall be transported separately to the blast site. Explosive shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Only the quantity of explosive required for a particular amount of firing to be done shall be brought to the site of work. All surplus explosives left after filling the holes shall be removed atleast 400 metres from the firing point.

A wooden tamping rod shall be used to push the cartridge into the shot hole. Metal rod or hammer shall not be permitted on the site of the works. The charges shall be pressed firmly into place and not rammed or pounded.

The explosive shall be fired by means of an electric detonator placed inside the cartridge and connected to the firing cable. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire.

Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling. The locations and depths of the holes shall be chosen so that the bed rock below the design level is not shattered and voids, fissures and cracks below



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this level are not formed. The rock pieces so blasted shall be neatly stacked at allotted places. Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory

regulations atleast 45 minutes before the firing time by sounding a warning siren. The area shall be encircled by red flags. All the operations shall be carried out by competent and experienced licensed supervisors. The number of shots fired at a time shall not exceed the permissible limits. Cases of the misfired unexploded charges shall be exploded by drilling a fresh hole along side the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge. The workmen shall not return to the site of firing until atleast half an hour after firing.

When blasting is conducted in the neighbourhood of roads, structures, buildings or any place which requires controlled blasting, only shallow shot holes shall be drilled. These holes shall be filled with a light charge of explosive and the blast controlled by placing steel plates with gunny bags filled with sand or earth over the holes and covering them with wire net fixed to the ground, so as to ensure that the blasted materials do not scatter.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc., shall be taken during blasting operations.

3.11 **Protection of existing utilities and services**

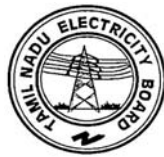
During construction, the contractor shall provide all protection for existing utilities and services as may be required by his construction operations. Permanent protection of certain items shall be as included under other sections or as instructed by the Owner.

In addition to the requirements as specified, herein the contractor shall comply with the following requirements:-

- a) Use all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances that must be kept in operation. In particular, the contractor shall take adequate measures to prevent undermining of utilities and services presently in services.
- b) Protect existing or new utilities and services where required by the contractor's operations and/or as directed by the Owner. The contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage.

3.12 **Dust control**

The contractor shall use all means necessary to control dust on roads, construction areas and borrow pits.



Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

3.13 **Dewatering during Construction**

3.13.1 **General**

This division applies to the methods and techniques of ground water control. Prior to the decision for the method and technique to be applied, a comprehensive knowledge of the soil and ground water conditions have to be obtained from the results of the soil investigation and/or information given in writing by the Owner.

All costs for ground water control for keeping the construction pits dry shall be included in the relevant excavation items of the lump sum except otherwise indicated.

The method and technique shall be based on the IS:3764.

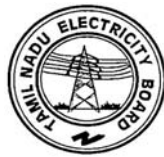
The scope of supply includes the installation of all equipment, plants, pipes, machinery, etc and its removal after completion including operation & maintenance of the equipment during the construction period.

Where necessary, cofferdams, sheet piles, pump sumps, equipment and channels, troughs, inlet gutters, pipes and any other works required for the water control and discharge shall be part of the scope of supply. The dewatering system shall be designed and installed in such a way that alterations and extensions can be made at any time throughout the operating time, if necessary. Reserve units shall be kept ready for service when failure of any of the installed units occurs.

The contractor has to consider the possibility of a temporary failure of any pump, diesel engine and/or the electric power service and shall install emergency power units with sufficient capacity to feed the necessary power to the installed unit at the moment of failure. The contractor shall submit to the Owner, the detailed method of the envisaged pumping system for dewatering, the pump capacity and the standby reserve units. The contractor shall adjust the system if required by the Owner.

The contractor must ensure that any dewatering works will not cause any interference to his own work and to those of other contractors working elsewhere on site or at structures under construction. Any damage occurring during the above mentioned period shall then be made good by the contractor at his own expense.

During the foundation works, the excavated areas, foundation levels, and pits are to be kept free of water down to at least 0.50 m below the foundation level.



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3.13.2 Equipment

All equipment, instruments, machineries, tools, pipelines, etc required for execution of the water control shall be in good repair and shall be kept in good working condition throughout the operation period.

3.13.3 Execution

Records: The contractor shall keep records of all data of importance occurring during operation of the water control system. The records shall be submitted to the Owner for information and checking every working day. For that purpose, the lowering of the water table shall be controlled by piezometers. The numbers and position of them shall be submitted to the Owner's approval. The contractor shall provide and maintain these piezometers at his own expenses during the dewatering works or as long as the Owner requires it.

Pump operations shall not be stopped nor pipes, channels and equipment for dewatering and water control removed or altered in any way, except with the express permission of the Owner. The Owner will stipulate the time of removal. Until then, the pumps and water drainage facilities shall be kept in proper working order without extra payment being granted.

Pump sumps and channels: Provision of pump sumps and channels of the dimensions required for each particular case shall include all necessary excavation of any kind of soil above and under water, backfill and consolidation, sheeting, bracing, stiffening, sealing, scaffolding accesses, as well as the disposal of water and all auxiliary works.

Routing of channels or pipes for discharge water shall be such as not to impede or obstruct any of the other works and/or operations.

The same shall be applicable for pump sumps. Prior to the determination of any arrangement of pump sumps, the Owner's approval shall be obtained.

Routing and location of water discharge lines shall be submitted to the relevant authorities and to the Owner's approval.

Difficulties during dewatering: The contractor shall consider all difficulties and additional work due to the presence of unexpected ground water during subsequent construction work. Where it is possible to keep off or divert such water without special dewatering arrangements or where work can be carried out normally under or in water, such a method may only be applied after approval from Owner has been obtained.

Ready for service condition: The contractor shall maintain ready for service and regularly clean all dewatering equipment and accessories and shall keep all access clear so that they can safely be used without risk of accident. Any recommendations made by the Owner in this matter shall be carried out immediately.



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Leakage: Blockouts and pipe connections through structures and their closure, proper grouting of joints, etc or repairs in the event of leakage shall be the responsibility of the contractor.

Piezometers: The ground water lowering effect is to be checked by piezometers in unfavourable positions (e.g. in the middle of the building pit) before starting the excavation. The piezometers are to be installed at unfavourable positions or in more permeable layers (in stratified sub-soil) below the bottom of the excavation. They serve to check whether or not the water pressure (head) has been sufficiently reduced in those layers below the bottom of the excavation which are more permeable. Security against hydrostatic uplift is to be demonstrated by calculation.

3.14 Test and Properties

3.14.1 General

The control of working and tests operations shall be carried out by the contractor in the presence of the Purchaser or Owner.

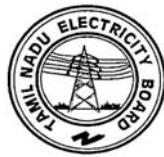
The contractor shall prepare sheets for statistical analysis of the field and laboratory tests, and shall submit the sheets to the Owner for approval. Controlling will consist of field and laboratory tests, such as compaction and density tests, grain size distribution and shear tests.

If not otherwise specified under relevant items, the following min. tests have to be carried out:-

- a) One (1) test analyzing the ingredients of the water used for performance of the work.
- b) Three (3) tests for specific gravity of soil as per IS:2720.
- c) One (1) test for bearing capacity of soil for static load as per IS:1888-1982.
- d) Three (3) tests for grain size analysis of soils, if "Replacement of Material" is required as per IS:2720.
- e) Three (3) tests of density of soil in place of sandcone method for each second layer of "Backfilling and/or Replacement of Material and/or Roadwork" are required as per IS:2720.

All tests shall be recorded in forms acceptable to the Owner.

Tests shall be performed for each 500 m³ of fill but not less than once per shift.



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3.14.2 Testing of select fill

Select fill, as specified herein, shall be provided as follows:-

- a) As fill or backfill within the limits of the structure/building and below basement floors as shown on the drawings to bring the subgrade up to the required elevation or for filling or backfilling against foundations walls and around footings.
- b) As fill beneath grade slabs or basement floors either to bring local low areas to grade or to replace disturbed or unsuitable soil.

Place select fill in approx. 15 cm layers (compacted thickness) and compact to 98% of maximum dry density (IS:2720).

Quality control shall establish all of the following values:-

- a) Unit dry weight
- b) Standard penetration test: 20 blows per 10 cm penetration.
- c) Plate load test as per IS:1888.

3.14.3 Testing of ordinary fill

Ordinary fill, as specified herein above, is required for all fill and backfill where special fill or select fill have not been specified on the drawings. Place ordinary fill in 15 cm layers (of compacted thickness) and compact to 95% of maximum dry density at optimum moisture content as per standard Proctor Density Test.

Quality control shall establish all of the following values:-

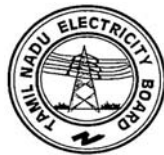
- a) Unit dry weight
- b) Standard penetration test: 16 blows per 10 cm penetration.
- c) Plate load test as per IS:1888.

3.15 Foundations

3.15.1 General

This clause describes all foundation works which are to be performed so as to ensure the bearing of all loads without detriment for and damage to the structures. The contractor has to choose up-to-date methods and equipment to ensure this in accordance with relevant internationally recognized standards.

The soil conditions met during the foundation works especially in the foundation level are to be checked by the contractor's soil Owner, recorded and compared with previous known or investigated results. If essential differences occur, which



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could be detrimental to the structures, the contractor has to inform the Owner and to propose further measures. Foundation works in such areas are to be continued only after approval of such measures by the Owner.

If there is any doubt about the soil quality or if discrepancies appear with regard to the previous decisions or investigations stated by the Owner, then additional measures are to be taken after consulting the Owner (e.g. additional excavation and lean concrete fill).

Immediately prior to concreting any footing, the contractor has to verify the specified soil conditions below the foundation level by a sounding.

For soil improvement works i.e. execution of special foundations (except replacement method) only special contractors (or sub-contractors) are acceptable subject to providing proof of experience in successful execution of such works in the form of a detailed description and references. Together with the description and the references a detailed execution programme including quality control measures relating to the actual site conditions is to be transferred to the Owner for approval.

Soil investigation at the plant site has not been done as yet, and detailed geo-technical investigation shall be required to be carried out to ascertain the safe bearing capacity and appropriate type of foundation for heavy equipment and structures.

The identified site for this project is mostly a filled up area. Detailed soil investigation would have to be done for foundation design. However the soil conditions of adjoining area given in the following paras can be used as initial idea.

Foundations in Adjoining Area:

It is understood that all the heavy structures for adjoining area were founded on the rock strata either directly or through piles and the main purpose of soil investigation was to know the depth of rock strata of the whole area.

General Condition of Soil in Adjoining Area:

Cohesive soils as sandy silt clayey silt from ground surface to the weathered rock were encountered in the area. Soils contained coarse sand and gravel near the ground surface. Underlying the soils, weathered rock were encountered. N-values of SPT in the upper part of the weathered rock were more than 70 and it was considered that the weathered rock could support loads transmitted from spread foundations and / or piles. Underneath the weathered rock, medium to hard rock is existing.

However, the Contractor shall carry out the soil investigation to determine soil characteristics and safe bearing capacity.



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The geo-technical exploration, testing and analysis information shall be used to determine the most suitable bearing method to support each foundation. The bearing method may include Owned fill, piling, drilled shafts, pressure injected footings or soil densification.

3.15.2 Factor of Safety for Bearing capacity

These are specified in Section 4.1 .

Static, dynamic and integrity tests shall be performed by an independent testing analyst.

3.15.3 Settlement criteria

These are specified in Section 4.1

3.15.4 Pitwall Stability

The excavated pit sides, walls or slopes have to be stable and established with respect to safety regulations:

IS:1200 (Part 1) Method of measurement of building and engineering work

IS:3764 Safety code for excavation work

3.15.5 Settlement and Expansion Joints

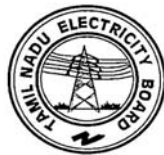
Joints are to be arranged in such a way that stresses and strains caused by settlements, temperature, differential settlement, etc do not adversely affect the structures. This primarily applies to differently loaded areas and structures having different foundations or foundations of different depths. The settlement joints shall run through the complete structure down to foundation level, the expansion joints however shall stop on the top level of foundations.

The joint width which is to be at least 2 cm is to be planned considering all relevant factors (settlements, tilting, movements, aspects etc.).

Settlements of all relevant structures shall be measured, recorded and shown in diagrams according to IS:8009 – “Code of Practice for calculation of settlement of foundation”.

3.15.6 Foundations at different depths

Foundations at different levels should be based beyond a load spread angle of 30° (against the horizontal). Otherwise, the load influence (e.g. earth pressure) of the higher level structures on the lower ones must be taken into consideration.



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3.15.7 Safety against uplift

For all parts of the structures extending into the ground water, safety against uplift has to be guaranteed during all execution stages, especially when ground water lowering is terminated.

3.15.8 Shallow foundations

In this clause shallow foundations are described where the footings rest on the natural bearing soil. For this kind of foundation especially the following standard is to be applied:

IS: 1080 Code of practice for design and construction of shallow foundations on soil

IS: 6403 Code of practice for determination of bearing capacity of shallow foundations

The excavation for the foundations can be done by machines, if the underground is not disturbed by this procedure. In every case, the last 20 cm above the foundation level are to be excavated by hand.

3.15.9 Replacement

If unsuitable soils are encountered below the grade slabs or basement floor, they are to be replaced by suitable layerwise compacted material down to the good bearing soil.

Materials and compaction method as well as quality control are described in clause 'Earth and Rockworks' of this section. Select fill is to be employed below all grade paving and basement floors.

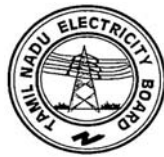
3.16 Special Foundation Requirements for Rotating Equipment

Special requirements for foundation for rotating equipment are indicated in Section 4.2.

4 CONCRETE WORKS

Reinforced concrete structures shall be designed in accordance with the latest Indian Standards IS 456-2000.

Water retaining RCC structures shall be designed in accordance to IS:3370 Part I to IV – Code of Practice for Concrete Structures for Storage of Liquids.



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4.1 Scope

The following works are covered by this section:-

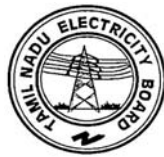
- a) furnishing and storage of materials,
- b) equipment and labour for processing of aggregate, mixing, testing, transport, pouring, vibrating, compacting, finishing and curing of concrete.

4.2

Standards

Unless otherwise specified, the following standards shall apply to the works covered under this chapter,

Cement	
IS:269	33 grade ordinary Portland cement.
IS:455	Portland slag cement.
IS:1489(Part-1)	Portland pozzolana cement – Fly ash based.
IS:4032	Method of chemical analysis of hydraulic cement.
IS:6452	High alumina cement for structural use.
IS:8041	Rapid hardening portland cement.
IS:8112	43 grade ordinary Portland cement.
IS:12269	53 grade ordinary Portland cement.
IS: 12330	Sulphate resisting Portland cement.
Aggregate	
IS:383	Coarse and fine aggregates from natural sources for concrete.
IS:460	Test sieves (All parts).
IS:2386	Methods of test for aggregates for concrete (All parts).
IS:2430	Methods of sampling of aggregates for concrete.
Concrete Plain and Reinforced	
IS:456	Code of practice for plain and reinforced concrete.
IS:516	Method of test for strength of concrete.
IS:737	Wrought aluminium and aluminium alloy sheet and strips for general engineering purposes.
IS:1199	Methods of sampling and analysis of concrete.
IS:1607	Methods for test sieving.
IS:1834	Hot applied sealing compounds for joints in concrete.
IS:1838(Part-1)	Preformed fillers for expansion joint in concrete pavements and structures (non extruding & resilient type)– Bitumen impregnated fibre.
IS:1893	Criteria for earthquake resistant design of structures.
IS:2645	Integral cement water proofing compounds.
IS:2750	Steel scaffolding.
IS:2974	Code of practice for design and construction of machine foundations (All parts).
IS:3370	Code of practice for concrete structures for the storage of liquids (All parts).
IS:4326	Earthquake resistant design and construction of buildings – code of practice.



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IS:6494	Code of practice for water proofing of underground water reservoirs & swimming pools.
IS:9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS:9103	Admixtures for concrete.
IS:9893	Precast concrete blocks for lintels and sills.
IS:10262	Recommended guidelines for concrete mix design.
IS:10297	Code of practice for design and construction of floors / roofs using pre-cast reinforced / pre-stressed concrete ribbed or cored slab units.
IS:10566	Methods of tests for preformed fillers for expansion joints in concrete paving and structural construction.
IS:10790	Methods of sampling of steel for prestressed and reinforced concrete (All parts).
IS:12118	Two parts polysulphide based sealants (All parts).
IS:13920	Ductile detailing of reinforced concrete structures subjected to seismic forces – code of practice.
SP:23	Handbook on concrete mixes.
BS:5606	Guide to accuracy in buildings.
ACI:347	Recommended practice for concrete formwork.
Reinforcing Steel	
IS:432(Part 1)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement.
IS:1566	Hard-drawn steel wire fabric for concrete reinforcement.
IS:1568	Wire cloth for general purposes.
IS:1786	High strength deformed steel bars and wires for concrete reinforcement.
IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:2751	Recommended practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works.
IS:9417	Recommendations for welding cold worked bars for reinforced concrete constructions.
SP:34	Handbook of concrete reinforcement and detailing.

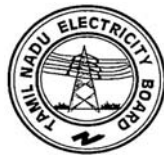
4.3 Materials

4.3.1 Quality of materials

The materials described below shall be specified and used as a basis for design.

Reinforcement shall be high yield strength deformed bars conforming to IS:1786 (Grade Fe415).

Cement: Ordinary Portland cement grade 43 conforming to IS-8112, shall be used in concrete mixes for general use viz. paving, lean concrete etc. Grade 53



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ordinary Portland cement conforming to IS-12269, shall be used for concrete mixes for all structural work and special structures and foundations.

Sulphate resistant cement, conforming to IS-12330, shall be used in concrete mixes when concrete is exposed to aggressive soil/water conditions.

Aggregates: Fine aggregates shall be clean natural sand. Coarse aggregates shall be crushed rock. All aggregates shall meet the IS requirements of IS:383.

Admixtures: Plasticizers and retarders shall be used to control setting time and to obtain optimum workability. Interior slabs to be trowel finished shall use less air entrainment. The use of calcium chloride shall not be permitted.

Water: Clean water of potable quality shall be used in all concrete mixes.

4.4 **Storage of Materials**

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration. Storage of materials shall conform to IS-4082 "Recommendation on stacking and storage of construction materials and components at site". Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the contractor.

4.5 **Cement**

4.5.1 **Sampling and testing of cement**

All deliveries of cement to the concrete supplier shall be accompanied by a certified mill test report and shall include all of the physical and chemical properties as required by relevant IS-12269 for grade 53 cement, IS-8112 for grade 43 and IS-12330 for sulphate resistant cement.

The manufacturer's test certificate will normally be accepted as proof of compliance with the specification, but the Owner may order further tests of a character specified in the appropriate Indian standards. The confirmatory tests are to be conducted by a recognized quality control organization. The contractor shall bear all expenses required for the preparation, despatch, and tests of the samples. In case the results of such tests show any sample to be inferior to specifications, the whole consignment from which the sample was taken shall not be used and shall be immediately removed from the site.

4.5.2 **Delivery and storage of cement**

The following information shall be provided for all cement shipments (either whole or part) which are intended for delivery to site: date of manufacture, date of original loading, destinations en-route, date of unloading, intended date of delivery to site.



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Cement which has been manufactured for longer than 6 months on the proposed date of delivery to the site shall be inspected, sampled and tested for approval purposes before delivery to the site.

The contractor shall obtain and provide to the Owner the manufacturer's Bulk Average Test Certificate for each consignment of cement to the works. The certificates shall be provided before the consignments are required for use and shall show the chemical composition and physical properties determined in accordance with the relevant standard.

Samples shall be taken from each consignment of cement and tested as directed by the Owner in an approved independent laboratory.

When bulk cement deliveries are proposed, the contractor shall provide all information required by the Owner concerning off-site storage and loading arrangements and shall provide reasonable facilities for the Owner to inspect these arrangements for approval purposes.

Consignments shall be used in the order in which they were delivered.

All bagged cement shall be stored in a weatherproof building having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements shall be fully completed and approved by the Owner before any cement is delivered to site.

Each consignment of cement shall be separately stored for ease of access, identification, inspection and sampling. Sufficient stocks shall be maintained on site to ensure the proper progress of the works and the stock holdings shall be to the approval of the Owner.

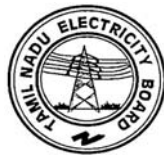
If bagged cement is stored in silos it shall be charged into the silos through at 6.3 mm mesh screen which is welded or bolted to and covers the entire feed area of the silo charging hopper.

Cement stored in silos shall be adequately protected against rain, humidity and dewfall, and all silo charging and discharging points shall be properly sealed. Silo aeration equipment shall if available, incorporate de-humidifiers.

No cement from any consignment shall be used in permanent works without the approval of the Owner.

Cement which contains air-set or hardened lumps, re-powdered air-set material, foreign matter or which has been contaminated or is otherwise unsatisfactory in the opinion of the Owner will be rejected and shall be removed from site without delay.

The contractor shall be responsible for satisfying himself that the performance characteristics of cement are not such as to necessitate excessive cement content or be likely to cause or accentuate any undesirable properties in the fresh or hardened concrete notwithstanding apparent compliance with this specification.



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4.6 Bulk cement shall be used for structures, bagged cement shall be used for masonry, plaster etc.

Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

pH value of water shall not be less than 6.

Non potable water may be used for the production of concrete and processing of aggregate provided the following requirements are satisfied:-

- a) The compressive strength of 150 mm cubes made and tested in accordance with IS:456 using the proposed water shall not be less than 90% of the average of strength of three similar concrete cubes prepared with distilled water.
- b) The initial setting time of test block made and tested in accordance with IS:4031 and containing the proposed water shall not be less than 30 min. and shall not differ by ± 30 min. from the initial setting time of control test block made with distilled water.
- c) The following chemical limits shall not be exceeded:
 - i) Chlorides (CL^-) < 2000 ppm
 - ii) Sulphates (SO_4^-) < 400 ppm
 - iii) Organic < 200 ppm
 - iv) Inorganic < 3000 ppm
 - v) Suspended solids < 2000 ppm

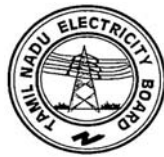
The concrete supplier shall provide chemical and physical test data for each source of water to be used prior to use.

When water is transported in tank trucks, each unit shall be accompanied by a chemical test report indicating compliance with the above requirements.

All water to be analysed by an independent laboratory before any work commences and at intervals as direct by the Owner tests and quality of water shall be in accordance with IS:456 or equivalent.

4.7 **Aggregates**

The aggregates for concrete shall be crushed natural rock subject to Employer/Owner's approval.



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The aggregate to be used in the work shall be supplied from an established pit or quarry. The aggregate source shall have a minimum five (5) years history of satisfactory performance in structural concrete and consistency of supply.

The concrete supplier shall obtain from the aggregate producer, or otherwise provide current test, examination, inspection reports performed and certified by an approved laboratory for submittal to the Owner.

As a minimum, this information shall include the following items:-

- Item 1 A comprehensive description, with current photographs of the pit or quarry, including but not limited to, identification by name and location, type of deposit, age, potential reserves, primary products by size including average gradation based on previous six (6) months production and the range for each sieve size; mining methods, process equipment, quality control organization and laboratory; the primary and alternate means of product transportation; listing of primary and secondary users of the product.
- Item 2 Petrographic examination in accordance with IS:2386 (Part-8) performed by a qualified concrete aggregate petrographer. This report shall be based on material produced and examined within the previous six (6) months and must be representative of the current production.
- Item 3 Coarse aggregate shall be sampled from current production in accordance with IS:2386 (Part 1 to 8). Three [20 mm, 10 mm & 5 mm] nominal maximum size (NMS) aggregates shall be sampled and tested as follows:-

IS 2386(Part 1):	Methods of test for aggregates for cement: Part 1 Particle size and shape (Amendments 3)
IS 2386(Part 2):	Methods of test for aggregates for concrete: Part 2 Estimation of deleterious materials and organic impurities (Amendment 1)
IS 2386(Part 3):	Methods of test for aggregates for concrete: Part 3 Specific gravity, density, voids, absorption and bulking
IS 2386(Part 4):	Methods of test for aggregates for concrete: Part 4 Mechanical properties (Amendments 3)
IS 2386(Part 5):	Methods of test for aggregates for concrete: Part 5 Soundness
IS 2386(Part 6):	Methods of test for aggregates for concrete: Part 6 Measuring mortar making properties of fine aggregates (Amendments 2)
IS 2386(Part 7):	Methods of test for aggregates for concrete: Part 7 Alkali aggregate reactivity



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IS 2386(Part 8): Methods of test for aggregates for concrete: Part 8
Petrographic examination

Aggregates when subjected to the tests defined in items above, unless otherwise approved by the Owner shall meet the requirements of IS:383 and IS:456.

Testing is to be carried out at the following intervals:

Type	Coarse Agg.	Fine Agg.
Grading	Daily	Daily
Specific Gravity	7 days	7 days
Magn Sulphate soundness	30 days	-
Clay, Silt and dust content	Daily	Daily
Shape (elongation and flakiness)	3.5 days	-
Los Angeles Abrasion	Initial stage only	Initial stage only
Moisture content	2 days	2 days
Drying shrinkage	Initial only	Initial only
Organic impurities	30 days	30 days
10% fines value for concrete	7 days	-

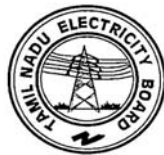
Combined grading also on a daily basis.

4.7.1 Storage and handling of aggregates

Cement and densified silica fume shall be stored in separate weather-tight buildings, bins or silos that will exclude moisture and contaminants. At least two cement silos are required with enough storage for a total of 400 metric tonnes of cements.

Aggregate stockpiles shall be arranged and used in a manner to avoid segregation and to prevent contamination with other materials or with other sizes of like aggregates. Aggregate delivery trucks shall be covered to prevent wind blown contamination. Aggregate stockpiles shall be located relative to prevailing winds to mitigate the accumulation of wind-borne dust.

Adequate storage shall be provided for each aggregate. The aggregate storage area shall be on concrete pavement sloped to drain excessive moisture. The aggregate storage area shall provide bulkheads to separate piles and protect



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against wind blown contaminants. Provision shall be made to shade and sprinkle the aggregates with potable water.

Aggregate stockpiles shall be built in successive horizontal layers not exceeding 1 m in thickness, with each layer being completed before the next is started. No vehicles shall be allowed to operate on top of the stockpiles.

Rescreening Coarse Aggregate: Rescreening and washing of coarse aggregates is required, if necessary, to reduce total chloride and/or sulphate contents to a level less than the maximum allowed by the specifications. If rescreening is required, the screening and washing shall be just prior to transferring aggregate to batch plant bins. Aggregates shall be dewatered over a screen to remove excess water before being stored in the batch plant bins.

Natural or manufactured sand shall be allowed to drain until it has reached a somewhat uniform moisture content before it is used.

Liquid admixtures shall be stored in such a manner to avoid contamination, evaporation and segregation in accordance with the manufacturers' recommendations.

4.7.2

Fine aggregate

Fine aggregate source shall be manufactured crushed stone or rock sand, excluding fines which are by products/rejects of coarse aggregate production. The crushed stone sand shall be graded from fine to coarse with the coarse sizes predominating to give maximum density.

The amount of fine particles as ascertained by the laboratory sedimentation method shall not exceed 10% for crushed stone nor 4% for natural sand.

The amount of material passing a 75 micron sieve (IS test sieve) shall not exceed the following limits:-

Crushed stone sand

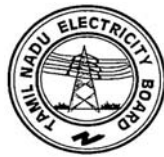
a)	concrete subject to abrasion	1% by weight
b)	all other concrete	3% by weight

There shall be no clay or fine silt present.

The amount of hollow shells like to form voids or remain partially unfilled and present in material retained on a IS 2.36 mm sieve, determined by direct visual separation, shall not exceed 3% by weight of the entire sample.

Fine aggregate shall not contain appreciable amounts of flaky and/or elongated particles.

The water absorption of fine aggregate, determined in accordance with BS 812 shall not exceed 2.0% by weight.



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Fine aggregate subjected to five cycles of the soundness test, specified in IS:2386 (Part-5), shall not show a loss exceeding 10% when sodium sulphate solution is used and 15% when magnesium sulphate solution is used, except where approved otherwise.

Tests are to be executed in accordance with IS:2386. The grading of fine aggregate for concrete work shall comply with the requirements of IS:383.

The grading of the aggregates should be such as to produce a concrete of the specified proportions which will work readily into position without segregation and without the use of an excessive water content. The grading should be controlled throughout the work so that it conforms closely to that used for the preliminary tests.

A check on the moisture content of sand should be made at least once a day before concreting. The amount of water to be added to the concrete mix should be adjusted accordingly. Any washing, screening, classifying and other operations on the fine aggregate required to meet this specification shall be done by the Contractor. Washing is required if the content of salt adhering to the aggregate is found to be unacceptably high.

4.7.3 **Coarse aggregate**

Coarse aggregate shall be crushed rock and shall be free from decomposed stone, clay, earth or other deleterious substances. The specific gravity of the coarse aggregate shall not be less than 2.5 t/m³. Aggregate of crushed natural stone is deemed adequate if the stone reveals a crushing strength of 1000 kg/cm² when tested. Friable, flaky and laminated pieces, mica and shale shall only be present in such quantities as not to affect the strength and durability of the concrete.

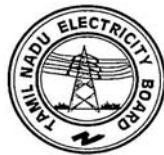
The grading of coarse aggregate for concrete shall comply with the requirements of IS:383.

Samples of aggregates shall be submitted to the Owner, together with sieve analysis showing the proportion by weight passing sieves. When aggregates which are satisfactory to the Owner have been selected, the contractor shall secure his entire supply of each material from the same source so as to maintain the same quality and grading throughout the work. Should it become necessary to change the source or characteristics of the material supplied this shall only be done after additional tests.

4.8 **Concrete Additives**

4.8.1 **Use of concrete additives**

Concrete additives approved by the Owner shall be used to improve consistency, workability, quality and strength of the concrete.



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Chemical admixtures manufacturer shall provide certified test reports from qualified independent laboratories showing actual test results indicating material that complies in all respects with the applicable specification.

Admixtures used in concrete shall conform to the appropriate specification and requirements as indicated below:-

- a) Air entraining admixtures shall conform to IS:9103.
- b) Water reducing and retarding admixtures shall conform to IS:9103. Accelerating admixtures shall not be used.

High range water reducers shall be naphthalene-sulfonated polymer based material. No admixtures containing chlorides shall be used.

- c) Chemical admixture suppliers shall provide certified test reports with each shipment indicating compliance with the appropriate specification. The test reports shall include the chloride content of the admixture, specific gravity and solids content.
- d) Fibres: Polypropylene fibres shall be collated, fibrillated polypropylene fibre of approved manufacture.
- e) Corrosion inhibitors: Reinforced concrete subject to contact with seawater and brine, as a result of submergence, splashing, spray, leakage from piping or plant, or from any other cause, shall have a proprietary concrete corrosion inhibiting compound incorporated into a concrete mix.

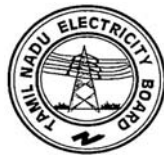
The corrosion inhibitor shall be appropriate to the protection of steel reinforcement against corrosion throughout the 25 year design life of the structures. The corrosion inhibitor shall be compatible with the required concrete mix and shall be appropriate to the environmental exposure. Before incorporating corrosion inhibitor into any concrete mix, the contractor shall submit details for review and written consent by the Owner.

The corrosion inhibitor shall be equivalent Bipolar concrete penetrating corrosion inhibitor (CPCI) and IRNET Epoxy Phenolic Coating System of CBRI Roorkee. The dosage of which shall be as per manufacturer's instructions.

Admixtures used in production of concrete shall be the same as used in establishing the required concrete mix and shall be used in accordance with the manufacturer's directions.

4.8.2 **Accelerating and retarding additives**

Such additives shall only be used in case of necessity and after obtaining the written approval of the Owner.



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4.8.3 Plasticisers and air entraining additives

Plasticisers and air entrainers are intended to reduce bleeding of free water at the surface. It shall only be used after the written approval of the Owner and in accordance with the manufacturer's instructions.

4.9 Concrete Mixes

4.9.1 General description and proportions and mixing

The mix proportions are to be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete is to be placed. The mix design shall be carried out by the contractor from approved agency. The design of mixes shall be based on the principles of IS:456-2000.

S.No.	Class	Grade of concrete	Minimum cement content (kgs/cum)	Maximum free water cement ratio
1.	Plain concrete used for lean concrete, screeds and backfill	M15	240	0.6
2.	a) Reinforcement concrete For structural work in foundation & superstructure	M25	300	0.5
	b) Reinforced concrete for water retaining structure	M25	330	0.5
3.	TG foundation deck	M40	360	0.4
4.	TG foundation substructure	M30	320	0.45
5.	Mill foundation & fan foundations	M30	320	0.45
6.	Chimney foundation	M25	365	0.5
7.	Chimney shell	M30	400	0.45
8.	Precast concrete	M25	300	0.5
9.	Pavement around buildings	M20	<u>330</u>	0.4
10.	Piling concreting	M25	400	.5
11.	Below ground level	M20	<u>370(HSRC)</u>	0.45
12.	Above ground level	M20	<u>330(OPC)</u>	0.45

Concrete aggregates and cement shall be proportioned and batched by weight. Water and liquid additives shall be proportioned. If the contractor wishes to use



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cement in bulk, his method of obtaining the correct proportions of cement shall be approved by the Owner before use.

4.9.2 Trial mixes

Before concreting commences, the contractor shall, at his own expense, make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing, transporting and compacting of the concrete with the equipment he proposes to use in any particular situation. Only materials which the contractor intends to use for concreting (including all admixtures) shall be used in the trial mixes.

Test cubes from trial mixes shall be made and tested in accordance with IS:516.

As per IS:456 and IS:516, three separate batches of concrete should be made, workability of each batch determined and three test cubes shall be made from each batch for each age (e.g. for 7 and 28 days) at which tests are required. The strength shall conform to target mean strength as per IS:456 – Requirements for design mixes.

The appropriate strength requirements may be considered to be satisfied if none of the strengths of the cubes is below the required characteristic strength and if the average strength of the nine cubes is not less than recommended by IS:456 and IS:516, trial mixes.

4.9.3 Quality and testing

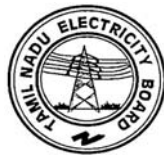
Not more than 5% of the test results may fall below the 28 days specified strength. Making and curing of test specimens shall be in accordance with relevant IS:456, IS:516 and IS:1199.

All mixes can only be placed following approval by the Owner. The mean strength shall exceed the characteristic strength by a margin of 1.65 times the standard deviation expected from the batching plant. However, no standard deviation less than 3.5 N/mm^2 shall be used as a basis for designing a mix.

4.9.4 Trial mixes and field tests

Sufficient laboratory trial mixes shall be effected to show that concrete complies fully with the specified performance criteria. The following tests are to be included:-

- a) Air content $< 1\%$
- b) Slump: Piles $170 \pm 25 \text{ mm}$, regular work $80 \pm 20 \text{ mm}$ as per IS:1199.
- c) Fresh and hardened concrete densities



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- d) Field trial mixes are to be carried out under full-scale site conditions as per IS:4925 (for structural concrete only).
- e) Where directed by the Owner, concrete incorporating reinforcement details shall be cored to assess stratification of mixes. Cores of 150 x 200 mm (dia and length) are to be used.
- f) Each trial mix shall have 9 x (150 x 150 mm) cubes taken to measure 24 hours/7 days and 28 day compressive strengths. These trials shall be run for three consecutive days (for structural concrete only).
- g) At least 3 x sets of field trials shall be tested according to the provisions laid down in laboratory testing.
- h) The average 28 day characteristic strength for trial mixes shall be higher by 10 N/mm² than that for cubes taken in the field. Failure to comply shall result in the mix having to be re-designed.
- i) All test results will have to be complied before approval can be given.

4.9.5 Consistency of concrete

The amount of water used in the concrete shall be adjusted as required to ensure such a consistency that it can be readily transported, placed and compacted without segregation of the materials or bleeding of free water at the surface. Addition of water to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of the concrete shall be checked by slump tests measured in accordance with IS-1199 and shall not exceed the values given in clause 7.1 of IS-456-2000.

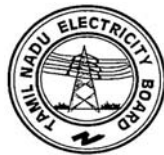
4.9.6 Mixing of concrete

The cement and aggregate shall be thoroughly mixed in a batch-type pull mill mixer. The capacity of the mixer shall not be less than 1 (one) cubic meter and the total capacity of the batching mixing plant shall be such to accommodate the various concrete quantities to be cast in a continuous way and shall comply with the requirements of IS:456, IS:1791 and IS:12119.

The water shall not be added until all the aggregate and cement are in the drum. Mixing shall continue until the concrete is uniform in colour and for not less than 2 (two) minutes after all the materials and water are in the drum.

Partly set or excessively wet concrete shall not be used. No concrete shall be mixed by hand.

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Owner for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the



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mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Owner. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Owner as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS:2722 may be used.

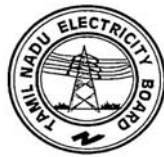
Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within $\pm 2\%$ of the quantity of Cement, water or total aggregates being measured and within $\pm 5\%$ of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Owner. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Owner, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Owner.



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4.9.7 **Laboratory**

The contractor shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time to the Owner.

The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards.

4.10 **Strength of Concrete**

4.10.1 **Testing of fresh concrete by means of test cubes**

All test cubes shall be made and tested for compressive strength in accordance with IS:456, IS:516 and IS:1199.

The minimum required strength for different classes of concrete is as shown in clause "General description and proportions and mixing" here-above.

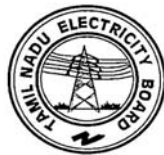
The grade of concrete required will depend partly on the particular use and the characteristic strength needed to provide the structure with adequate ultimate strength and partly on the exposure conditions and the cover provided to any reinforcement.

A minimum of four test samples (of six test cubes each) shall be taken on each concreting day (from the same mix) and for at least each 40 m³ of concrete mixed. At least one sample shall be taken for each shift.

For columns, beams and cantilevers seven (7) cubes for every 15 m³ of concrete poured shall be taken. The concrete for test samples shall be taken directly from the concrete mixer and shall be handled (vibrated etc) under similar conditions to those prevailing during the construction. The moulds for the test cubes shall be made of steel. Tests shall be carried out in an approved laboratory.

The strength level of each type and each strength concrete will be evaluated separately and the concrete strength will be considered satisfactory if:

- i) **Compressive strength:** The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:-
 - a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of Table 11 of IS:456.
 - b) Any individual test result complies with the appropriate limits in col. 3 of Table 11 of IS:456.
- ii) **Flexural strength:** When both the following conditions are met, the concrete complies with the specified flexural strength:-



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- a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2 .
- b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm^2 .

If the results are less than those specified, the Owner must suspend all concreting work and order further tests. Any concrete found not to comply with the specification shall be broken out and replaced to the satisfaction of the Owner.

The contractor shall pay all costs incurred in making, curing, delivering and testing of concrete cubes.

4.10.2 Testing of concrete in structures

The types of tests described hereinafter are applicable to the finished parts of the structures. They may be used in routine inspection and for quality control.

Type of tests:

- a) Cutting cores: The procedure used shall comply with the requirements of IS:516 or an approved equivalent standard.
- b) Gamma radiography: The testing shall be carried out in accordance with the requirement of IS:13311 Part 1 or equivalent.
- c) Ultrasonic test: Such tests may be used to obtain approximate indications of the strength of the concrete in the structures (IS:13311 Part 1).
- d) Electromagnetic cover measuring devices: Such tests may be used to verify the position of the reinforcement and shall be in accordance with the requirements of design (IS:13311 Part 1).
- e) Rebound hammer test: Such tests may be used to obtain approximate indications of the strength of the concrete (Ref. IS:13311, Part 2).
- f) Load tests of structures or parts of structures: If the results of the above mentioned check tests show that the quality of the materials is inadequate or if other defects are revealed, the Owner may require a loading test to be made.

For the purpose of testing floors, roofs and similar structures and their supports, the test load shall be equivalent to the sum of the characteristic dead load and one-and-a quarter times (1.25 times) the characteristic imposed load for a period of 24 hours which the works or part thereof to be tested have been designed.

Wherever certain procedures for testing of parts in structures (e.g. piles) are required by standards or codes of practice, these are to be followed. All tests must be conducted in the presence of the Owner.



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If within 24 hours of removal of the imposed load, the structure does not recover at least 75% of the deflection under superimposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80%, the structure shall be deemed to be unacceptable.

If the result of the test is not satisfactory, the Owner shall instruct that the part of the works concerned be taken down or cut and reconstructed to comply with this specification. The contractor shall at his own cost take down or cut out and reconstruct the defective work.

The Owner may require other tests to be made. Number of samples, tests and types will be as per Owner requirements.

All the costs for the above mentioned tests shall be borne by the contractor.

4.11 **Transport of Concrete**

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods which will prevent the segregation, loss or contamination of materials. The concrete shall be placed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site.

The concrete shall be transported in dumpers or trucks. Before using concrete pumps, placer pipelines, chutes or spouts it is necessary to have the written approval of the Owner.

The contractor shall obtain permission at least 24 hours in advance of any concrete pour.

4.12 **Concreting Operations**

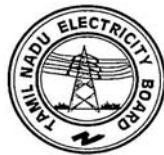
4.12.1 **Inspection prior to concreting**

All concreting methods shall be subject to the approval of the Owner.

Concrete placing shall not be started until the Owner has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

4.12.2 **Placing of concrete**

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns and similar members.



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The contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

The temperature of concrete shall not exceed 40°C measured at discharge into the works.

The maximum allowable temperature of any point within any cast element is 60°C. The maximum allowable temperature differential between any two points in the same element is 15°C. Additional temperature control measures during construction (such as the use of insulated formwork) will be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements.

Temperature monitoring of concrete work is required where:

- a) the minimum dimension of any casting is 0.8 metres or more, or
- b) where otherwise instructed by the Owner.

Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours time shall be subject to the same treatment as the construction joints.

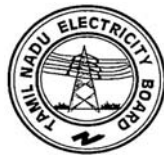
Concrete shall not be dropped into place from a height exceeding 1.5 metres. Trunking and chutes to Owner's approval shall be used for any concrete to be deposited from a height exceeding 1.5 m.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

4.12.3 **Compaction and mechanical vibration of concrete**

As concrete is being placed it shall be compacted by mechanical vibrators complying with IS:2505, IS:2506, IS:2514 & IS:4656, to obtain a dense material free from honeycombing, free from water and air holes.

The contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.



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4.12.4 **Finish of concrete**

The concrete face shall have the finishes indicated on the drawings or in the present specification. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

4.12.5 **Construction, expansion and contraction joints**

4.12.5.1 Construction joints

The number of construction joints should be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings. Alternatively, the location of joints should be subject to agreement between the Owner and the Contractor before any work commences. Construction joints should be at right angles to the general direction of the member and should take due account of shear and other stresses.

Concrete should not be allowed to run to a feather edge and vertical joints should be formed against a stop board.

The top surface of a layer of concrete should be level and reasonably flat unless design considerations make this undesirable. Joint lines should be so arranged that they coincide with features of the finished work.

If a kicker (i.e. a starter stub) is used it should be at least 70 mm high and carefully constructed. The kicker must be incorporated with the previous concrete. Where possible, the formwork should be designed to facilitate the preparation of the joint surface, as the optimum time for treatment is usually two to four hours after placing.

The maximum horizontal length of wall to be poured in one operation in any one direction is 7.5 metres. A period of 7 days to be allowed between adjacent pours except where water stops are provided when this can be reduced with Owner's approval. Alternatively a gap of 600 mm wide shall be left between adjacent pours and filled after 7 days from the date of formation subject to Owner's approval.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast should be free from laitance and should be roughened to the extent that the largest aggregate is exposed but not disturbed. Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against it.



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Particular care should be taken in the placing of the new concrete close to the joint. This concrete should be particularly well compacted and if possible a vibrator should be used.

Where the Owner considers that special preparation is necessary, i.e. for an in-situ structural connection, preparation should be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush, which is sufficient to remove the outer mortar skin and expose the larger aggregate. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking of hardened surfaces should be avoided.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

4.12.5.2 Expansion and contraction joints

The expansion joints, contraction joints and other permanent structure joints shall be provided in positions as shown in the drawings.

Joints shall be straight and vertical, except where other specified, and concrete surfaces on both sides of the joint shall be flush. Where necessary, waterstops of a type approved by the Owner shall be embedded in the concrete. The waterstop should be made of high quality material which must obtain its resilience through the service life of the structure for the double function of movement and sealing. The surface of waterstops should be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints the waterstop should be provided with anchor parts. The cross-section of the waterstops should be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

All joints between structural steel and concrete parts shall be sealed by a suitable permanent flexible compound.

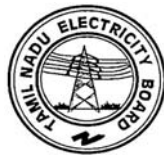
4.12.6 Concreting at night

When approval is given to carry out concreting operations (under control of the Owner) at night or in places where daylight is excluded, the contractor has to provide adequate lighting at all points of mixing, transportation and placing of concrete.

4.12.7 Concreting in high ambient temperature

"IS:7861 (Part 1) – concreting in hot weather" shall apply.

The temperature of the mixed concrete at the time of placement shall not exceed 40°C. The contractor shall take special measures in the mixing, placing and curing of concrete. These measures shall include the shading of aggregates,



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spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water) and reduction of transportation time to the minimum. During placing suitable measures shall be provided to prevent premature setting of concrete placed in contact with hot surfaces. All concreting areas, formwork and reinforcement shall be shielded from the direct rays of the sun and sprayed with water when necessary.

4.12.8 **Protective measures for concrete**

In general, the cover of rebars shall be as per IS:456 taking into account the site conditions. However, the minimum concrete cover shall not be less than:

a)	Concrete parts above ground (external surface)	:	40 mm
b)	Concrete exposed to underground & groundwater	:	50 mm
c)	Slabs	:	20 mm
d)	Beams	:	25 mm
e)	Columns	:	40 mm

Immediately after the compaction of the concrete has been finished, the contractor shall ensure adequate protection from the weather. Excessive drying can lead to crack formation as a result of plastic contraction. The concrete surface shall be covered with a layer of sacking, canvas, straw mats or similar absorbent material, special protection sprays kept constant moist for at least 7 days.

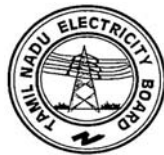
Curing compounds or other methods of preventing evaporation may be used if approved by the Owner. Where formwork cannot be removed within 24 hours after placing the concrete, the formwork shall be kept shaded from the direct rays of the sun and shall be sprayed with water.

Owner's approval to the use of a particular curing compound and to the method of application will only be given after the contractor has completed satisfactory site trials and a sample panel has stood for at least 28 days.

Where large sections of concrete are poured, special precautions to the approval of the Owner shall be taken to reduce and dissipate the heat generated by the setting and hardening of the concrete (e.g. built-in cooling water pipe system).

The minimum amount of reinforcement shall be present to prevent shrinking cracks.

No load of any kind, however light, shall be allowed on concrete which has not properly set and the contractor shall prevent any load to be imposed on the concrete structures until it has been declared by the Owner to be ready to carry loads.



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4.12.9 **Concreting under-water**

Underwater concreting shall be done as per IS:456. Underwater concrete must comply with the following characteristics:-

- a) The quantity of cement must be not less than 350 kg/m^3 when using aggregate mixes with a maximum particle size of 40 mm.
- b) The water-cement ratio must not exceed 0.6.
- c) Preferred aggregates are those with continuous grading curves lying approximately in the middle of the favourable range.
- d) Slump shall be as per clause 7.1 of IS:456.

Underwater concrete is to be placed continuously without interruption. For water depths upto 1 m the concrete may be placed without tremie. In the case of water depths exceeding 1 m, the concrete is to be placed in such a way that it does not fall freely through the water. The tremies must at all times dip sufficiently far into the freshly placed concrete to ensure that the concrete emerging from the tremie does not come into contact with the water.

All work connected with the placing of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. Work shall not proceed until all phases and methods to be used in the placing operations have been approved by the Owner.

4.13 **Concrete with Special Properties**

4.13.1 **General requirements**

The pre-condition for obtaining concrete with special properties is that it should be made with the appropriate composition, that it is placed in such a way that segregation does not occur and further that it is fully compacted and given appropriate curing.

4.13.2 **Waterproof concrete**

This concrete must meet the provisions of IS:3370. Waterproof concrete must be sufficiently dense (impermeable).

4.13.3 **Waterproofing and protection of underground concrete structures**

Water aggressive to concrete should be kept away from the fresh concrete.

Concrete which is exposed for a prolonged period to “very severe” chemical attack must be protected against direct access of the aggressive substances.

The protection, which is to be laid as protection to all concrete surfaces in contact with the ground, shall consist of an approved waterproofing membrane. The



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membrane shall adhere to all concrete surfaces, including undersides of structures and other surfaces where concrete is cast in contact with the membrane.

Such membranes shall be PVC sheets of minimum 0.35 mm thickness with knobs of Maxlock supplied by Maxcorona Owners Pvt. Ltd., or equivalent.

The waterproof membranes shall be installed in strict accordance with manufacturer's instructions.

The membranes shall extend 15 cm above ground level.

When setting forms and reinforcing steel caution shall be exercised to avoid damage to the impervious membrane. The surface of the impervious membrane extending outside the forms shall be protected during subsequent operations.

Any puncture or damaged areas shall be cleaned and patched according to manufacturer's instructions.

4.13.4 **Concrete with high wearing resistance**

Concrete which is exposed to severe mechanical action, e.g., due to intensive traffic, sliding of bulk materials, frequent impact blows or movements of heavy objects, or due to fast-flowing water carrying solids, or other causes, should possess high wearing resistance and correspond at least to grade 30.

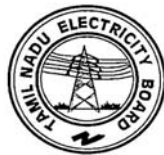
The aggregate upto 4 mm size should consist predominantly of quartz or materials of at least equal hardness; the coarser particles should consist of stone or artificial materials possessing high abrasion resistance. In the case of particularly severe mechanical action, it will be necessary to use special hard materials. The particles of all types of aggregate should have a moderately rough surface and be of compact shape. The combined aggregate should be as coarsely graded as possible.

Furthermore, the concrete should be as stiff as possible, in order that there will be no concentration of cement slurry or water in the top layer. The concrete should be kept moist for at least 7 days after placing.

4.14 **Finishing of formed surfaces**

Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that shall be covered with earth backfill. Exterior surfaces that shall be exposed above grade and all interior surfaces, except those not usually exposed to view, shall be cleaned and rubbed. Rubbing shall produce a smooth, uniform surface free of marks, voids, surface glaze, and discolorations.

Rubbing shall be done by hand with a carborundum stone using only the mortar produced by the rubbing action and the application of water.



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Projecting ends of all form ties shall be removed. The resulting recesses shall be cleaned, wetted, and filled with patching mortar. Patches on rubbed surfaces shall match the texture of the adjacent concrete.

4.15 **Finishing of unformed surfaces**

No surface treatment shall be required for buried or permanently submerged concrete. As a minimum, unformed surfaces shall be finished by screeding and floating. Surfaces requiring a trowelled finish shall be finished by screeding, floating, and trowelling.

Float finished and screeded surfaces shall be finished to provide a flat profile within a 6 mm deviation as measured from a 3 meter straightedge. Trowel finished surfaces shall be finished to form a flat plane. The surface profile shall not deviate more than 3 mm when measured from a 3 meter straightedge.

4.15.1 **Screeding**

Screeding shall provide a concrete surface conforming to the designated elevations and contours with all aggregates completely embedded in adjacent mortar. Surface irregularities in screeded surfaces shall be limited to the tolerances specified.

4.15.2 **Floating**

The surfaces shall be screeded and given an initial float finish as soon as the concrete has stiffened sufficiently to work. Coarse aggregate disturbed by the float or causing a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a smooth float finish of uniform texture and color.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

4.15.3 **Trowelling**

The exposed portions of the tops of equipment bases, tops of interior curbs, and the surfaces of interior slabs not receiving a separate finish shall receive a steel trowel finish. Trowelling shall be performed after the second floating when the surface has hardened sufficiently to prevent excess cement from being drawn to the surface. Trowelling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

Surfaces to be covered with neoprene-hypalon coatings shall be lightly trowelled but not burnished.



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4.15.4 Brooming

Brooming shall follow the float finish for exterior surfaces where a nonslip surface is required. Brooming shall be done with an acceptable steel or fiber broom not less than 450 mm wide. Brooming ridges shall be transverse to the normal traffic direction and shall be between 1.5 mm and 3 mm deep. Adjacent strokes of the broom shall overlap slightly. Broomed surfaces shall be free of porous spots, irregularities, depressions, and small pockets or rough spots.

4.15.5 Aggregate Exposure

Surface mortar shall be removed and the aggregate exposed from surfaces that shall be covered with mortar, concrete, or grout at a later time.

4.15.6 Edging

Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having a 6 mm corner radius.

4.15.7 Finishing mortar

Finishing mortar shall be added if there is not sufficient mortar available from the concrete mix. The proportions for this finishing mortar shall be 102 kilograms of concrete sand to one bag of Portland cement, mixed with enough water for proper application. Slump for finishing mortar shall not exceed 50 mm.

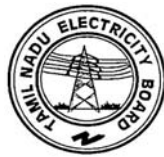
4.16 Separate finishes

Certain slab surfaces shall be finished with a separate concrete finish or floor covering.

Base slab surfaces shall be ground or filled until each surface is within the specified tolerances. Low areas shall be filled. High spots shall be ground slightly lower than required and then filled and smoothed to the proper elevation and surface.

Surfaces that receive epoxy set quarry tile and resilient tile shall be flat with a profile that shall not deviate more than 3 mm from a 3 meter straightedge placed on any part of the surface. These surfaces shall be either trowel finished concrete at the elevation indicated on the drawings or a float finished surface set 3 mm low and leveled with trowel finished fill material.

Surfaces that receive a mortar set quarry tile, ceramic tile, or terrazzo finish shall be given a smooth, tight, and uniform float finish with a profile tolerance of 6 mm as measured from a 3 meter straightedge.



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4.17 Formwork

4.17.1 Design and construction

For stability and type of formwork and support framing used, IS:14687 is to be observed.

The formwork and the supporting structure are to be so dimensioned as to be able to withstand all vertical and horizontal forces safely.

Supporting structures shall be sufficiently rigid to maintain the forms in their correct position and to be true to shape and dimensions so that the final concrete is within the limits of the dimensional tolerances specified in section 5.1.3(c) "Dimensional Tolerances".

The contractor shall submit in sufficient time in advance for the approval of the Owner the calculations, designs and details of the methods adopted and materials proposed for the formwork.

Particular attention must be paid to the formwork supports and braces to avoid any slip when the concrete is poured.

4.17.2 Materials for formwork

Forms shall be constructed from steel or from sound timber well seasoned and free from shakes. Plywood lining for forms shall be of timber which is resin-bonded and water repellent.

Formwork surfaces in contact with concrete shall be free from adhering grout, projecting nails, splits or other defects.

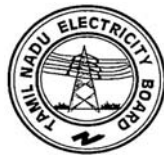
Joints shall be sufficiently tight to prevent the leakage of cement grout. Connections shall be constructed to permit easy removal of the shuttering and shall be either nailed, screwed, bolted, or otherwise secured so as to be strong enough to retain the correct shape during consolidation of the concrete. Where a slope exceeds 1 V : 2 ½ H formwork shall be provided for the top of the concrete faces and anchored to prevent flotation.

The details of fair faced concrete facades have to be to the satisfaction of the Owner. The concrete surface for facades has to be absolutely stainless and all efforts have to be taken to achieve this.

4.17.3 Grading of formwork and of finished concrete surfaces

Quality of formwork, materials to be used and treatments of surface are graded according to the finish of the concrete surface as given in IS:14687.

The type and treatment of the formwork lining (plywood, metal, plastics, etc) should be appropriate to the grade of concrete finish required.



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4.17.4 Preparation and inspection of formwork

Before concrete is placed, all formwork shall be inspected to see if it is built according to the approved plans and to see if it has been cleaned and is free from sawdust, shavings, dust, mud, earth or other contamination and properly oiled. Contact surfaces of panels shall be treated with a suitable release agent (e.g. non-staining mineral oil) where applicable. Surfaces which are not oiled shall be wetted thoroughly to prevent warping.

4.17.5 Erection and placing of formwork

All formwork shall be erected and placed in accordance with the construction drawings approved by the Owner. Shuttering shall be true to line and braced and struttred to prevent deformation under weight and pressure of the wet concrete, live-loads, wind and other forces. The deflections shall not exceed 3mm.

The formwork for beams and slabs shall be erected so that the form on the sides of the beams and of the soffits of slabs can be removed without disturbing the beam soffit.

If the formwork for columns is erected to the full height of the columns, one side shall be provided with openings for concreting in order to guarantee a proper compaction of the poured concrete.

Formwork for walls and elsewhere shall be arranged for a maximum concreting height of 2.5 m in a single pour. Where necessary panel openings are to be provided in the forms for cleaning, inspection, access of vibrators, etc.

Before placing of concrete, bolts, ties and fixings shall be positioned and all devices used for forming openings, holes, pockets, chases, recesses, etc shall be fixed to the formwork carefully.

Panels shall be put together to ensure a perfect fit at the joint and fixed in both directions.

Where concrete surfaces will be exposed to view (permanently exposed surfaces) the formwork shall be such as to produce a completely true, smooth surface, free from perceptible irregularities or to show clearly the desired texture. Such formwork shall be marked on the drawings as "Fair-faced Formwork".

Where concrete surfaces will be covered (non-exposed surfaces), the formwork shall be referred to and marked as "Sawn Formwork".

Internal spacers and ties, if any, shall be so arranged that after removing of the forms no holes shall extend through the concrete, in the case of watertight concrete or to be closed by plastic plugs and epoxy mortar in all other cases.



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All formwork will be inspected and approved by the Owner before concrete placing commences but this shall not relieve the contractor of any of his responsibilities under the contract.

4.17.6 Striking of formwork

Formwork shall not be removed until the concrete has sufficient strength to carry its own weight plus any constructional or designed loads likely to be applied with a normal factor of safety. It shall be removed in such a manner that no shock or injury shall result to the concrete.

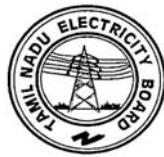
Before removal of the formwork, the concrete shall be examined and removal shall proceed only on the instructions and under the supervision of a competent person.

In accordance with IS:456 clause 11.3.1, the striking period for cast in-situ concrete under certain conditions may be taken as follows:-

TYPE OF FORMWORK		Minimum period before striking formwork
a)	Vertical formwork to columns, walls, beams	16 to 24 hours
b)	Soffit formwork to slabs (props to be refixed immediately after removal of formwork)	3 days
c)	Soffit formwork to beams (props to be refixed immediately after removal of formwork)	7 days
d)	Props to slabs:	
	1) Spanning upto 4.5 m	7 days
	2) Spanning over 4.5 m	14 days
e)	Props to beams and arches:	
	1) Spanning upto 6 m	14 days
	2) Spanning over 6 m	21 days

Special care is necessary in the case of components which have to carry nearly the full calculated load as soon as the formwork is struck.

Columns, piers and walls are to be struck before the beams and slabs supported by them. Scaffolds, formwork supports and self-supporting floor formwork are to be carefully lowered by releasing the devices.



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Extreme care shall be taken to avoid chipping of corners during removal of formwork.

To keep deflections through creep and shrinkage to a small amount, auxiliary supports should be left in place or immediately repositioned after striking.

4.18 **Reinforcing Steel**

4.18.1 **General**

Reinforcing steel used in reinforced concrete shall comply with the following standards:-

- a) Deformed bars conforming to IS: 1786.
- b) Fusion bonded epoxy coated bars conforming to IS: 13620 – 1993.
- b) Mild steel conforming to IS: 432.
- c) Mesh reinforcement conforming to IS: 1566.

In the event of presence of alkalinity or corrosive nature of soil, fusion bonded epoxy coated rebars shall be used for all foundations upto plinth level and in TG deck.

4.18.2 **Binding wire**

- 1) Plastic coated binding wires to be used for epoxy coated rebars.
- 2) Binding wire for general use shall be 1.6 mm dia galvanized annealed wire.

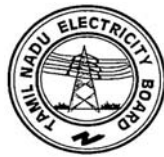
4.18.3 **Reinforcement supports**

Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening the reinforcement.

Spacers shall be cast from concrete of the same quality as that in which they will be embedded.

Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size.

Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the contractor shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.



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4.18.4 **Certificates**

Each consignment of steel reinforcement shall be accompanied by a test certificate from the manufacturer showing that the steel has been tested and analysed and the date of such tests and analyses and that such tests and analyses comply in all respects with the standards. The following tests shall be carried out on reinforcement:-

- a) Cast analysis
- b) Carbon equivalent value
- c) Tensile strength, yield stress, elongation
- d) Bend test
- e) Bond classification
- f) Chemical analysis

4.18.5 **Epoxy coating of reinforcement**

Wherever epoxy coated reinforcement is used, reinforcing bars, fabric and special steel connections shall be protected against corrosion by means of an epoxy coating as per IS:13620.

At the same time, the contractor shall furnish written certification from the coating applicator that the coated reinforcement bars were cleaned, coated and tested in accordance with the requirements of this specification.

Coating materials shall be heat-cured epoxy resin powders applied by electrostatic spray process. The thickness of the coating shall be 250 μm .

Reinforcement bars which are to be coated shall be clean and free from rust, scale, oil, grease and similar contaminants. The surface shall be abrasive blasted to Swedish Standard SA3. As soon as possible after cleaning and before any visible oxidation to the surface occurs, the steel shall be coated with a fusion-bonded powder epoxy coating applied by electrostatic process.

4.18.6 **Stock of reinforcing steel**

In order to ensure due progress of the works, the contractor shall at all times maintain on the site a stock of reinforcing steel sufficient for the following month's work. No reinforcing steel shall be used upon the works until it has been accepted as satisfactory by the Owner.



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4.18.7 Rejection

The Owner at his discretion may order random testing of the reinforcement steel and in the event of any failed test reject the entire lot notwithstanding the manufacturer's or coating applicator's certificates.

The contractor shall remove all rejected reinforcing steel from the site without delay at his own expense.

4.18.8 Production handling of Epoxy coated bars

Bars shall be handled and stored in a manner to prevent damage to the coating. Bars or coating damaged in handling or other operations shall be satisfactorily repaired at no additional cost to the Employer. All systems for handling the coated bars shall have padded contact areas wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong-back or spreader bar with a minimum of three supports to the bundle. The bars or bundles shall not be dropped or dragged. Extra care in handling of these bars will be beneficial to the contractor in reducing or eliminating in place coating repairs.

4.18.9 Storage

All bars for reinforcement and steel fabric reinforcement shall be stored on the site under cover on timber or concrete supports suitably spaced and of sufficient height to keep the steel not less than 150 mm clear of the ground.

4.18.10 Bar-bending schedules

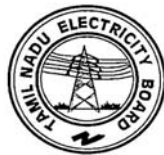
The contractor shall prepare bar bending schedules based on the detailed reinforcement drawings. These shall be presented to the Owner for approval. Approval of these schedules by the Owner in no way absolves the contractor from full responsibility for their completeness and correctness in every way nor shall any claim for extra cost or time be allowed on the grounds of such errors or discrepancies which may arise between drawings and schedules.

4.19 Waterstops

Water stops shall be PVC or equivalent and shall be eye-letted with a minimum 25 cm width. Type and manufacturer shall be submitted to the Owner's approval.

All intersection pieces shall be prefabricated by the manufacturer and only welding of butt-joints in running lengths will be allowed to be carried out on the site.

The site welding of butt-joints shall be executed by using the manufacturer's purpose-made electrically heated jig and work shall be done by a competent and trained personnel only. The manufacturer's instructions shall be carefully observed.



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The wings of the waterstops shall be formed with corrugations or bulbs to achieve a good bond. Moreover, the waterstops shall conform to the following requirements:-

- a) The tensile strength not less than 10 N/mm^2 when tested.
- b) The ultimate elongation shall not be less than 22% when tested.
- c) The tear resistance shall not be less than 2 N/mm^2 when tested.
- d) The material shall not crack when tested.
- e) Under accelerated elongation, the tensile strength shall not be less than 8 N/mm^2 and the ultimate elongation shall not be less than 200%.

The waterstops shall be installed so that they are securely held in position during the placing of concrete which shall be fully and properly compacted around the waterstops to prevent voids or porous areas. Adequate clearance between the reinforcement and all the waterstops shall be kept to permit proper compaction of concrete.

No holes or nailing shall be made through any waterstop for fixing purposes. Jointing by lapping two pieces of waterstops shall not be permitted.

The free edges of waterstops shall at all times be protected from direct sunlight.

4.20 **Curing**

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed.

Trowelled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish.

4.20.1 **Water curing**

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Water curing shall begin within 12 hours in dry weather and within 24 hours in damp weather. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water may be interrupted for surface rubbing. The concrete surface shall not be permitted to dry.

After the rubbing has been completed, rubbed surfaces shall be covered with burlap and kept saturated for the remainder of the curing period.



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4.20.2 Membrane curing

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface. Membrane curing compound shall be spray applied at a coverage of not more than 7.4 square meters per liter. Membrane curing shall not be used on surfaces that shall be covered at a later date with mortar, concrete, damp-proofing, tile, or any coating. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks.

4.21 Floor Sealer

All concrete floors shall be given two coats of clear floor sealer in addition to that applied as membrane curing compound. The first coat shall be applied at the end of the curing period before any traffic is permitted on the floor. The second coat shall be applied after the floor has been cleaned in preparation for the final inspection. Floor sealer shall be applied in strict accordance with the manufacturer's recommendations.

4.22 Repairing of Damaged or Defective Concrete

Concrete which has completed its final setting shall be inspected by the Owner and any cracks, honeycomb areas, segregations, etc shall be marked. No repairs shall be carried out until direction by the Owner.

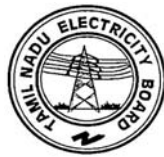
Surface defects in formed concrete shall be repaired to the satisfaction of the Construction Manager within 24 hours. Concrete that is porous, honeycombed, or otherwise defective to a depth in excess of 25 mm shall be cut out and removed to sound concrete. Edges shall be square cut to avoid feathering. Cut surfaces shall be coated with epoxy bonding compound before the concrete is placed.

Defective concrete shall be replaced within 48 hours after the forms have been removed.

Concrete repair work shall not interfere with the curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and shall be finished to match adjacent surfaces.

4.23 Waterproofing

A waterproofing seal shall be provided for all below grade structures where applicable by external tanking with PVC sheets of 1.0 mm thickness with knobs for membrane type water-proofing. In addition, joints in deep underground structures shall be provided with structural water-proofing.



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4.24 Damp Proofing

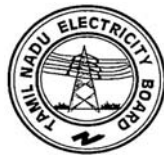
Damp-proof course 40 mm thick, consisting of cement concrete 1:2:4, with admixture of approved water-proofing compound shall be laid at plinth level for walls of all buildings for protection of super-structure against moisture and dampness.

4.25 Standard Grouting

4.25.1 Ordinary grout shall be provided for miscellaneous structure base plates viz. operating platforms (not supporting equipment), pipe supports upto 2.5 m height (above concrete top), cross-over, staircases and ladders.

The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Based on requirement for obtaining non-shrink grout, aluminium powder may be used as an admixture. The grout proportions shall be limited as follows:-

	Use	Grout thickness	Mix proportions	W/C ratio	
4.25.2	a)	Fluid mix	Under 25 mm	One part Portland cement to one part of sand	0.44
	b)	General	25 mm and over but less than 50mm	One part Portland cement to 2 parts of sand	0.53
	a)	Sand shall be such as to produce a flowable grout without any tendency to segregate.			
	b)	Sand for general grouting purposes shall be graded within the following limits:-			
	i)	Passing IS 2.36 mm sieve	:	95 to 100%	
	ii)	Passing IS 1.18 mm sieve	:	65 to 95%	
	iii)	Passing IS 300 micron sieve	:	10 to 30%	
	iv)	Passing IS 150 micron sieve	:	3 to 10%	



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- c) Sand for fluid grouts shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.
- 4.25.3
 - a) Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.
 - b) Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted.
- 4.25.4
 - a) Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.
 - b) Water in anchor bolt holes shall be removed before grouting is started.
- 4.25.5 Forms around base plates shall be reasonably tight to prevent leakage of the grout.
- 4.25.6 Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.
- 4.25.7 Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release entrapped air link chains can be used to work the grout into place.
- 4.25.8 Grouting through holes in base plates shall be by pressure grouting.
- 4.26 **Special Non-Shrinking Grout**
- 4.26.1 Special grout, where specified on the drawings, shall be provided in strict accordance with the manufacturer's instructions/specifications. Pre-mixed Grout Conbextra GP-2 of 'FOSROC' make or equivalent of crushing strength 650 kg/cm² for major equipment foundations and Conbextra GP-1 having crushing strength of 450 kg/cm² for other foundations where concrete grade M25 or higher is provided.
- 4.26.2 Forms and shims used to obtain adequate clearance shall not be removed and the anchor bolts shall not be tightened for at least three days after placing the grout. After the removal of forms and shims, area occupied by shims shall be filled and the area between the base and edge of the foundation shall be finished smooth to allow drainage away from the base. Attachment of interconnecting piping of machinery and complete load transfer of machinery shall not be done before the bolts are tightened. During this period, grouting work shall be properly cured using rags/gunny bags.
- 4.26.3 In view of extremely small proportion (about 0.01% by weight of cement) of the aluminium powder required, it is necessary to take all precautions to ensure



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thorough mixing. It is advisable to mix the blend of aluminium powder thoroughly with sand and cement before water is added because aluminium powder has a tendency to float on water.

4.26.4 Proprietary material of approved manufacture used as an admixture to obtain non-shrinking grout shall be mixed in the proportion of 1:1:1 (1 cement: 1 admixture: 1 sand), or as per manufacturer's instructions.

4.26.5 Pre-mixed non-shrinking grout shall be used all as per manufacturer's instructions and without any additional materials/admixtures such as cement, sand and aggregates etc.

5 STRUCTURAL STEEL WORK

PART I FABRICATION OF STRUCTURAL STEEL WORK

5.01.00 SCOPE

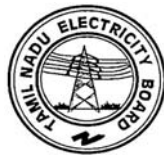
This specification covers supply and/or taking delivery of raw steel materials from owner's stores, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

5.02.00 GENERAL

5.02.01 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :-

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on design drawings to be furnished by the Owner.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.



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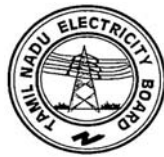
- d) Prepare and submit monthly materials reconciliation statement showing effective utilization of raw steel materials as received from Owner's stores.
- e) Furnish quarterly and monthly requirement of matching steel sections for maintaining required progress of fabrication in accordance with the approved programme and take delivery of all raw steel materials from Owner's stores or supply of such matching steel sections in case the same are not supplied by the owner.
- f) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be to the extent of actual requirement plus 10% (ten percent).
- g) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- h) Suitably mark, bundle and pack for transport all fabricated materials.
- i) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- j) Insure, load and transport all fabricated steelwork field connection materials to site.
- k) Furnish necessary test certificates of all raw steel material supplied by the Contractor.

5.02.02 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

5.02.03 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-



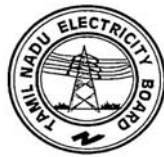
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LIST OF IS CODES - RELEVANT TO FABRICATION OF STRUCTURAL STEEL WORK

IS Codes	Description

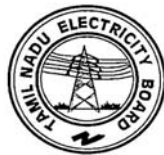
IS:800	- Code of practice for general construction in steel.
IS:801	- Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS:806	- Code of practice for use of steel tubes in general building construction.
IS:808	- Dimensions for rolled steel beams, channels and angle sections.
IS:812	- Glossary of terms relating to welding & cutting of metals.
IS:813	- Scheme of symbols for welding.
IS:814	- Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS:815	- Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS:816	- Code of practice for use of metal arc welding for general construction in mild steel.
IS:817	- Code of practice for training & testing metal arc welders.
IS:818	- Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS:819	- Code of practice for resistance spot welding for light assemblies in mild steel.
IS:822	- Code of practice for inspection of welds.
IS:919	- Recommendations for limits and fits for (Part - 1&2) engineering.
IS:1161	- Steel Tubes for structural purposes.
IS:1182	- Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS:1200	- Method of measurement of steel work and iron (Part - 8) work.
IS:1239	- Mild steel tubes, tubular and other wrought (Part - 1&2) steel fittings



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- IS:1363 - Hexagon head bolts, screws and nuts of product (Part - 1 to 3) grade C.
- IS:1364 - Hexagon head bolts, screws and nuts of product (Part - 1 to 5) grade A & B.
- IS:1365 - Slotted counter sunk head screws (dia. 1.6 to 20 mm)
- IS:1367 - Technical supply conditions for threaded steel (Part - 1 to 18) fasteners.
- IS: 1608 - Method for tensile testing of steel products.
- IS:1730 - Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
- IS:1852 - Rolling and cutting tolerances for hot-rolled steel product.
- IS:1977 - Structural steel (Ordinary quality)
- IS:2016 - Plain washer
- IS:2062 - Steel for general structural purposes.
- IS:2629 - Recommended practice for hot-dip galvanizing of iron and steel.
- IS:2633 - Method for testing uniformity of coating on zinc coated articles.
- IS:3644 - Code of practice for ultrasonic pulse echo testing by contact and immersion method.
- IS:3757 - High Strength Structural Bolt
- IS:4000 - High strength bolts in steel structure
- IS:4759 - Specifications for hot-dip zinc coatings on structural steel and other allied products.
- IS:4923 - Hollow steel sections for structural use.
- IS:5334 - Code of practice for magnetic particle flaw detection of weld.
- IS:5369 - General requirements for plain washers and lock washer.
- IS:6005 - Code of practice for phosphating of iron and steel.
- IS:6649 - Specification for hardened and tempered washers for high strength structural bolts and nuts.



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- IS:6623 - Specification for high strength structural nuts.
- IS:7215 - Tolerances for fabrication of steel structures.
- IS:7280 - Bare wire electrode for submerged arc welding
- IS:8500 - Structural steel micro alloyed (medium & high strength quality).
- IS:8629 - Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.
- IS:9595 - Recommendation for metal arc welding of carbon manganese steels.

PAINTING

- IS:117 - Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
- IS:128 - Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
- IS:1477 - Code of practice for painting of ferrous metal (Part - I & II) in building.
- IS:2074 - Ready mixed paint, air-drying red-oxide zinc chrome priming.
- IS:2339 - Specification for aluminium paints for general purposes in dual container.
- IS:2932 - Specification for enamel, synthetic exterior type - I.
- IS:2933 - Specification for enamel, synthetic exterior type - II.

5.02.04

Conformity with Designs

Except where the standard connection details are furnished, the contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer Keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.



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5.02.05 Materials to be used

a) General

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant.

If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

b) Steel

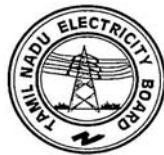
All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable : -

- 1) IS : 801 - Cold formed light gauge steel structural member.
- 2) IS : 806 - Steel tubes in general building construction.
- 3) IS : 1161 - Steel tubes for structural purpose.
- 4) IS : 1977 - Structural steel (Ordinary quality) St-42-0
- 5) IS : 2062 - Steel for general structural purpose
- 6) IS : 8500 - Structural steel-microalloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

c) Electrodes

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable : -



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- 1) IS : 814 - Covered electrodes for metal arc welding structural steel
- 2) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- 3) IS : 7280 - Base wire electrode for submerged arc welding.

d) Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

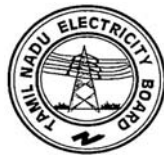
- a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of $5.6 \sqrt{A}$, where 'A' is the cross sectional area of the test specimen : -

- 1) IS:1367 - Technical supply conditions for threaded

fasteners.

- 2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

- b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.



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e) Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract : -

- 1) IS : 1977 - Structural steel (Ordinary Quality) St-42-0
- 2) IS : 2062 - Steel for general structural purpose
- 3) IS : 8500 - Structural steel – microalloyed (medium & high strength quality)
- 4) IS : 6623 - High Strength Structural Nuts
- 5) IS : 6649 - Hardened and tempered washers for high strength structural bolts & nuts.

f) Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimer Paints Ltd., or equivalent) may be necessary.

5.02.06

STORAGE OF MATERIAL

a) General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

b) Steel

The steel to be used in fabrication and the resulting cut pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.



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c) Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

d) Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

e) Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

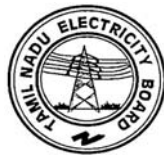
5.02.07

Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work. The quality control procedure shall cover but not be limited to the following items of work : -

- 1) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- 2) Bolts, Nuts : Manufacturer's certificate, dimension Washers checks,
Material testing.



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3)	Electrodes	:	Manufacturer's certificate, thickness and quality of flux coating.
4)	Welders	:	Qualifying Tests
5)	Welding sets	:	Performance Tests
6)	Welds	:	Inspection, X-ray, Ultrasonic tests
7)	Paints	:	Manufacturer's certificate, physical inspection reports
8)	Galvanizing	:	Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot- Dip Zinc coatings on Structural Steel and other allied products.

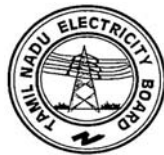
5.02.08 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

5.02.09 Shop Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall within forty five (45) days after the award of the contract start to submit progressively for approval, the shop drawings based on the Design Drawings furnished to him and, before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centerline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates. The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.



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The shop drawings shall include but not be limited to the following : -

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolt location etc.
- c) Details of all connections with supporting calculations.
- d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.
- e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked-up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

5.03.00 WORKMANSHIP

5.03.01 Fabrication

a) General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards or equivalent.



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b) Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

c) Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

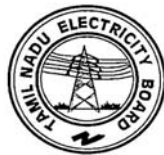
To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

d) Planing of edges

Planing or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

e) Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.



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5.03.02 Bolted construction

a) Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

b) Assembly

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are either twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the drawings.



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5.03.03 **Welded Construction**

a) **General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

b) **Preparation of Material**

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

c) **Assembling**

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

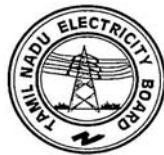
d) **Welding Sequence**

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

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. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

e) **Welding technique**



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All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm 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. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

f) Temperature

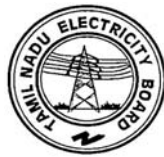
No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

g) Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over Peening.

h) Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity



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as recommended by the manufacturers of electrodes or as may be approved by the engineer.

5.03.04 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

5.03.05 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

5.03.06 Lacing bars

The ends of lacing bars shall be neat and free from burrs.

5.03.07 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

5.03.08 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

5.03.09 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

5.03.10 Shop connections

- a) All shop connections shall be welded as specified on the Drawings.



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- b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes at no extra cost to the Owner.

5.03.11 **Castings**

Steel castings shall be annealed

5.03.12 **Shop erection**

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

5.03.13 **Shop painting**

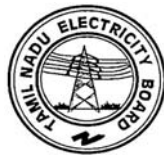
a) **General**

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow- coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand- wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall be immediately painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy resin based zinc rich primer such as Blast Steel EZ1 of Shalimer Paint Limited or equivalent.



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b) Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

c) Contact surfaces

Contact surface shall be cleaned in accordance with Sub-clause 3.13.01 before assembly.

d) Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

e) Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

5.03.14 Galvanizing

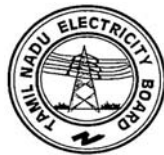
a) General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

b) Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.



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c) Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

5.04.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

5.04.01 Inspection

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.



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5.04.02 **Testing and Acceptance Criteria**

a) **General**

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

b) **Steel**

All steel supplied by the Contractor shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be borne by the Contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

c) **Testing Criteria for checking Lamination in raw steel plates**

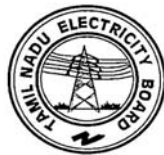
All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

- (1) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.
- (2) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item is found to be laminated, the component will be rejected.

d) **Welding**

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage



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shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor. In the event of further tests as may be desired by the Engineer, the cost of such test shall be borne by the Contractor if the results are found to be unsatisfactory; and if the test shows no defect, the cost shall be borne by the Owner. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken free of charge to the Owner.

e) Bolts, nuts and washers

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor.

f) Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

g) Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

5.04.03 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.



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5.04.04 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory, the costs shall be borne by the contractor, and if satisfactory, the costs shall be borne by the Owner.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

5.04.05 Delivery of materials

a) General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

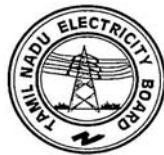
b) Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

c) Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to the worksite and also for securely protecting and packing the materials to avoid loss



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or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following : -

- a) Name and address of the consignee
- b) Name and address of the consignor
- c) Gross weight of the package in tonnes and its dimensions
- d) Identification marks and/or number of the package
- e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

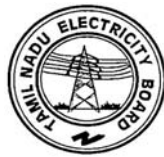
Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water- proof envelope, quoting especially -

- a) Name of the Contractor
- b) Number and date of the Contract
- c) Name of the office placing the contract
- d) Nomenclature of stores
- e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner without any extra payment.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.



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The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.05.00 INFORMATION TO BE SUBMITTED

5.05.01 With Tender

The following information are required to be submitted with the Tender :

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

- 1) Preparation and approval of shop drawings
- 2) Procurement of materials
- 3) Fabrication and shipping of all anchor bolts
- 4) Fabrication and shipping of main steelwork
- 5) Fabrication and shipping of steelwork for bunkers. Tanks and / or silos as applicable.
- 6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork
- 7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.



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b) **Shop**

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

5.05.02 **After Award**

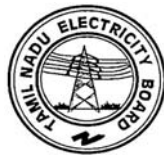
After award of the Contract the successful Tenderer is to submit the following : -

- a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings furnished to him in accordance with the approved schedule.
- b) List of phase wise requirement of matching steel section in six (6) copies in accordance with the approved schedule shall be submitted within 2 (two) weeks after the award of the contract, and/or receipt of the design drawings.
- c) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- d) Detailed monthly material reconciliation statements relevant to the work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials and scrap.
- e) Results of any test as and when conducted and as required by the Engineer.
- f) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

PART II ERECTION OF STRUCTURAL STEEL WORK

5.01.00 **SCOPE**

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site, and/or from Owner's Site Stores or store Yard, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.



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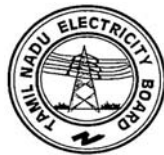
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5.02.00 **GENERAL**

5.02.01 **Work to be provided for by the Contractor**

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures if required by the Contract.
- g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-
 - i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size bolt if required.
 - iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.



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Welding in place of bolting will be permitted only at the discretion of the Engineer.

- v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.
- vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- viii) Carry out tests in accordance with this Specification if directed.

5.02.02 Work by others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

5.02.03 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

IS-800	:	Code of Practice for general construction in steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12843	:	Tolerance for erection of Steel Structures

5.02.04 Conformity with designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and /or the instructions of the Engineer.



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5.02.05 **Material**

a) **General**

All fabricated steel structures and connection materials shall be supplied by the Contractor for fabrication work. The Contractor for erection work will take delivery of all the materials from the storage yard at Site. The Contractor may also have to take delivery directly from railway wagons or trucks at Site as per terms & condition of the contract, in which case he shall have to unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified herein before.

While taking delivery, the Contractor will check the quantity, quality and the sizes of the materials and verify the adequacy of the same in accordance with the Drawings and Specifications. In case the Contractor finds any material inadequate, he shall inform the Engineer immediately prior to taking delivery of the same. No claim whatsoever, in respect of bad quality, shortages or difference in size will be entertained once the delivery is taken and the Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the Contractor's Own cost.

Excepting all field connection materials like bolts, nuts, washers and electrodes, which will be supplied by the fabrication Contractor to the extent of 10% in excess of the estimated requirements as per Drawings, all other consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

b) **Materials to conform to Indian Standards**

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

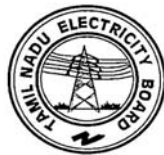
5.02.06 **Storage of materials**

a) **General**

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

b) **Yard**

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials. The yard shall



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have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

c) Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

5.02.07 Quality control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:

a)	Erection	:	Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
b)	Grouting	:	Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, Consistency and strength of grout.
c)	Painting	:	Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

5.02.08 Taking Delivery

The erection Contractor shall take delivery of fabricated structural steel and necessary connection materials supplied by the fabrication Contractor from railhead, trucks and/or the Owner's stores at site as may be necessary and as per terms & conditions of the contract or as directed by the Engineer. He shall check, unload, transport the materials to his stores for proper storing at his own cost. The erection Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.



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The erection contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted.

5.03.00 **WORKMANSHIP**

5.03.01 **Erection**

a) Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

b) Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

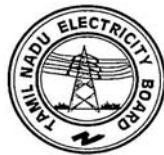
c) Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the steel erection and shall return to the Owner's store in good condition if the materials are supplied by the Owner otherwise permission shall be given to Contractor to take out the materials from the project site. The Owner may remove and return the materials in good condition to the Contractor without any charge if they have been left in place under other agreed arrangement.



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d) Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

e) Setting out

Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

f) Field bolting

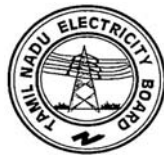
All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

i) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an



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impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8xdia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

ii) **Torque Wrench tightening**

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.



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TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

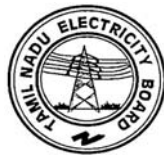
In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

g) Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.



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h) Holes, cutting and fitting

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and / or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

5.03.02 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

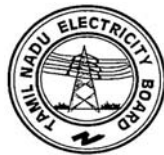
5.03.03 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" or equivalent may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementitious grout (ready mixed) like "Sika grout - 214", or "Anchor NSG" or approved equivalent.



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No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally leveled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

5.03.04 **Painting after erection**

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, leveled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project. The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

5.03.05 **Stainless Steel Plate Lining in Bunker Hopper**

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 to 6 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing & specification.

The stainless steel liner shall be fixed to the tanker hopper MS shall be plug welding using special electrodes (such as, Inox-CW coding AWS-310-16, ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by



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Advani Oerlikon Ltd. or equivalent). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways as per drawings. The plug welding shall be ground flush with the lining plate.

5.03.06 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

5.03.07 Safety Measures during Erection

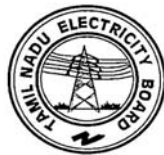
The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slinging, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

5.04.00 TESTING AND ACCEPTANCE CRITERIA

5.04.01 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract of either fabrication or erection of steelwork whoever is responsible for it and no payment towards the cost of the dismantled portion and any connected work shall be made to the Contractor, unless it is proved that the deficiency is due to reasons beyond the Contractor's scope. On the basis of the tests, the Engineer will decide whether the fabricator or the erector is responsible for the unacceptable member or structure and his decision will be final. In case it is established that the unacceptability of the member or structure is due to design deficiency, the cost of replacement and/or modifications will be borne by the Owner. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor responsible, to the satisfaction of the Engineer. The cost of the tests specified hereinafter shall be borne by the Owner. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.



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a) Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

b) Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

c) Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.



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d) Repair for subsequent test and use after strength tests

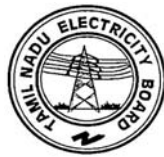
An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.01.02 herein before and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01. herein before.

5.04.02 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below:

I. For Buildings Containing Cranes

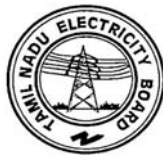
Component	Description	Variation Allowed
Main columns	a) Shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
Component	Description	Variation Allowed
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels :	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height any 10M	ii) ± 3.5 mm from true vertical for length measured



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			between connection levels, but not more than ± 7.0 mm per 30 m length
	c)	For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d)	For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
Component		Description	Variation Allowed
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least
Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b)	Deviation to crane rail gauge	± 3.0 mm
	c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm



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- d) Deviation of crane rail axis from centre line of Web. $\pm 3.5 \text{ mm}$

Setting of Expansion gaps

At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C.

The coefficient of expansion or contraction shall be taken as 0.000012 per Deg. C per unit length.

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be $\pm 3.0 \text{ mm}$ on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

5.04.03 Acceptance

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.05.00 INFORMATION TO BE SUBMITTED

5.05.01 Before Tender

Along with the Tenders the Tenderers will be required to submit the following information :

a) Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.



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b) Constructional Plant and Equipment, Tools, Temporary Works & Manpower

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

c) Erection yard

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.05.02 After award of the Contract

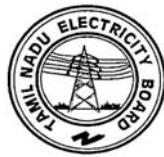
After award of the contract, the Contractor shall submit the following:

a) Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

b) Weekly Progress Report

The Contractor shall submit weekly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular week must be made up within the next week. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.



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7 MASONRY AND PLASTERING WORKS

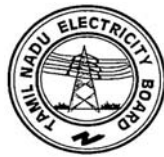
7.1 General

This chapter covers the furnishing and installation of all brick work, damp-proof courses and plastering works.

7.2 Standards

Unless specifically mentioned otherwise, all applicable codes and Standards in their latest editions as published by the Indian Standards Institution and all other such as may be published by them during the currency of the Contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

IS:1077	Common burnt clay building bricks
IS:1542	Sand for plaster
IS:1661	Code of practice for application of cement and cement-lime plaster finishes
IS:1661	Code of practice for application of cement and cement-lime plaster finishes
IS:2116	Sand for masonry mortars
IS:2212	Code of practice for brickwork
IS:2250	Code of practice for preparation and use of masonry mortars
IS:2691	Burnt clay facing bricks
IS:2691	Burnt clay facing bricks
IS:3495	Methods of tests of burnt clay building bricks
IS:3696	Safety code for scaffolds and ladders (All parts)
IS:5454	Methods of sampling of clay building bricks



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7.3

Materials

Cement

Cement used for mortar shall be ordinary Portland cement conforming to IS:269 / IS:8112 / IS:12269 or Sulphate resisting cement conforming to IS:12330.

Sand

The sand shall be approved river or pit sand and it shall conform to IS:2116 for masonry mortar and to IS:1542 for plaster mortar.

Mortar

Cement Mortar for brickwork shall conform to IS:2250. The cement mortar to be used shall be in proportion of 1:6 for full brick walls and 1:4 for half thick brick walls.

Water

Water for mixing and curing shall comply with the requirement of IS:456

Bricks

The bricks used shall be of Class 50 bricks conforming to IS:1077 having a minimum compressive strength of 50 kg/cm². Bricks are to be whole, uniform texture, sound, well burnt, free from cracks, square and well shaped, uniform in size, uniform red cherry or copper colour and shall emit a clear ringing sound when struck. Slight distortion or rounded edges are permitted provided no difficulty arises during laying of uniform course.

Water absorption after 24 hours immersion shall not exceed 20% by weight. Dimensional tolerance shall not exceed 8%. Representative samples shall be submitted and approved samples shall be retained by the Consultant for future comparison.

7.4

Storage and Handling

Bricks shall not be dumped at site. These shall be stacked in regular tiers on firm ground, even as these are unloaded, to minimise breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.



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7.5

Workmanship

Brick work

Whole of the brickwork shall be carried out by the Contractor in a uniform manner. All the bricks shall be kept under water till they are completely soaked and shall be used for the works on their becoming skin dry. The Contractor shall set out and build all brickwork to the dimension, thickness and heights shown on the drawings. The Contractor shall build all brickwork in English bond and half brick walls and casing to pipe, chases etc in stretcher bond. Brickbats shall not be used except where required for bond.

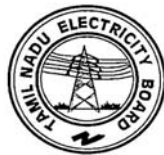
The Contractor shall lay bricks in full mortar beds with shoved joints. The joints are not to exceed 10 mm in thickness and are to be full of mortar, close, well finished and neatly struck. The vertical joints in any course shall not be nearer than quarter of a brick length from those in the course below. All joints shall be of same width except for small variations to maintain bond. The brickwork shall be laid plumb and trim to line and level. No portion of brickwork shall be raised more than 1 metre above another at one time. If the mortar in any course has begun to set, the joints shall be raked out before another course is laid. The top course of brickwork in reinforced concrete framed structure shall be wedged against reinforced concrete surface and joint well filled with mortar. The Contractor shall flush up thoroughly with mortar all joints as the work proceeds. Where brickwork is to receive plaster, the joints shall be raked to a depth of 10 mm to provide proper bond.

All half brick walls shall be reinforced with 2 nos. 8 dia bars at every fourth course. All masonry units shall be bonded to concrete and steel columns by galvanised metal wall ties (4mm thick, 50mm wide 200mm long) at the rate of one tie at every fourth course.

The brickwork as it progresses shall be thoroughly watered on its faces and top. New work shall be properly bonded with the old work. The surface of unfinished work shall be cleaned and thoroughly wetted before joining new work to it. Any work in which the mortar perishes shall be dismantled and rebuilt by the Contractor.

The Contractor shall carry out work in as clean a manner as possible and shall remove excess material and mortar droppings daily. Where brick walls are to receive plaster, excess materials and mortar droppings shall be removed and the surface shall be brushed clean. During cleaning operations, adjacent work shall be protected. Any damage resulting from improper protection shall be made good by the Contractor at his own cost.

Encasing of structural steel shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Consultant. The minimum lap in chicken wire mesh shall be 50 mm. Other steel embeddings shall be generally embedded in mortar and masonry unit shall be cut as required.



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Plastering

Unless otherwise specified, all plaster work shall be carried out according to IS:1661. The thickness and proportions of cement plaster shall be as specified in the drawing.

The surface to be plastered shall be cleaned of all extraneous matter and rubbish. In brickwork the joints shall be raked and concrete surface roughened by chipping or hacking. Any shuttering material adhering to the concrete shall be removed. The Contractor shall make plaster pads of the required thickness of plaster for correctness of plumb, line and level. The surface shall be thoroughly watered and soaked and aerated and all holes shall be closed before starting plastering operation.

Plaster, when more than 15 mm thick shall be applied in two coats - a base coat followed by the finishing coat. Thickness of under coat shall be of sufficient to fill up all unevenness in the surface, no single coat, however, shall exceed 15 mm in thickness.

For one coat plaster work, the plaster shall be laid slightly thicker than the specified thickness and the surface then levelled with flat wooden rule to the required thickness. The plaster shall be well pressed into the joints and the surface finished as specified.

For two coats of plaster work, the first coat shall be applied as described above except that the surface shall be left rough and keys formed for the application of second coat. The second coat shall be applied a day or two after the first coat has set, but the first coat shall not be allowed to dry. The second coat shall consist of mortar ground very fine and shall be laid on with a wooden rule to a specified thickness, rubbed smooth and levelled and the surface plastered completely the same day. The levelling shall be continued till the plaster is quite dry and all moisture that exudes from the plaster shall be wiped off with a fine cloth. The surface shall be kept dry until exudation of moisture ceases, during the process of rubbing.

Sand Faced Plaster

The plaster shall be applied in two coats. The first coat or the scratch coat should be approximately 14 mm and shall be continuously carried out without breaks to the full length of wall or upto doors, windows etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines to provide bond for finish coat. The scratch coat shall be cured for at least 7 days and then allowed to dry.

The second coat shall be 6 mm thick and it shall not be applied until at least 10 days have elapsed after the application of the first coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation and without joints, finish shall be straight, true and even. Only approved river sand shall be used for the second coat and for finishing work. Sand for finish shall be of even coarse size and shall be dashed on the surface and sponged.



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Plaster-Of-Paris Punning

Plastered surfaces, where specified, shall be finished with plaster-of-paris punning. The thickness of punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation. Before bulk work is taken up, a sample of punning shall be done on roughly 1 sq.m area and approval of Consultant taken. The work shall then completed as per approved sample.

7.6

Curing

The brick masonry works shall be cured for a period of fourteen (14) days after laying and the plaster shall be cured for a period of seven (7) days.

7.7

Expansion & Separation Joints

Location and details of expansion joints shall be strictly as shown in the drawings. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints, if any, shall have to be got approved by the Consultant.

Separation joints shall be with standard water proof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Consultant.

7.8

Damp Proof Course with Cement Concrete

The proportion of cement to aggregates shall be 1:1½:3 using 6 mm down stone chips with a waterproofing admixture. The percentage of waterproof admixture shall be as per manufacturer's specification but not less than 1% by weight of cement. The brick masonry surface shall be levelled, flushed up and prepared as directed to receive the damp-proof course. The thickness of damp proof course shall be 40 mm. In masonry walls of buildings it shall normally be placed above the external ground level. It shall be laid for the full width of the wall. The top surface shall be kept rough or ribbed for proper adhesion of mortar for brickwork coming over it. All exposed surfaces of the damp proof course shall be finished fair and smooth. It shall be cured for at least seven days. After the surface has partially set, it shall be cleaned with brushes and finally with a piece of cloth lightly soaked in kerosene oil. Then hot bitumen (residual petroleum bitumen of penetration 80/100 of approved quality) shall be applied over the prepared surface in two coats at the rate of 1.7kg per sq. meter per coat and dry sand spread over it.

7.9

Sample Panels

Sample panels of external finish shall be executed for the demonstration of colour and surface texture to the satisfaction of the Purchaser / Consultant.

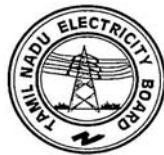
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WATER PROOFING

8.1

General

The work covered by this chapter shall include the requirements in respect of materials, workmanship and quality for water proofing of roofs and underground structures.



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8.2

Standards

Unless specifically mentioned otherwise, all applicable codes and Standards in their latest editions as published by the Bureau of Indian Standards and all other such as may be published by them during the currency of the contract, shall govern in respect of design, workmanship, quality and properties of materials and method of testing. Some of the relevant available codes are listed hereunder:

IS:1322	Bitumen felts for water proofing and damp proofing
IS:1346	Code of practice for waterproofing of roofs with bitumen felts
IS:1580	Bituminous compounds for water proofing and caulking purposes.
IS:1609	Code of practice for laying damp-proofing treatment using bitumen felts
IS:2645	Integral cement water proofing compounds
IS:3067	Code of practice for general design details and preparatory work for damp-proofing and water-proofing of buildings.
IS:7193	Specification for glass fibre base coal tar pitch and bitumen felts.

8.3

Materials

Membrane water proofing

Membrane water proofing treatment with 'Roofosol' two component coating or equivalent. 30 mm thick Polyurethane foam spray insulation with a density of 40 to 45 kg/m³ shall be provided conforming to IS: 13205. The roof surface shall be finished with concrete/brick tiles.

Bitumen Felt

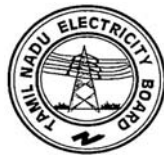
Bitumen felt shall be used for water proofing and damp proofing and shall conform to IS:1322.

Bituminous Polymeric Membrane For Roof Water Proofing.

Bituminous Polymeric membrane used for waterproofing of roofs shall be 5 layered membrane consisting of a central core of 90 microns thick High Molecular High Density Polyethylene (HMHDPE) film protected on both sides with polymeric asphaltic mix and further covered on both sides with protective thermo-fusible HMHDPE film. For precast roofs, the top HMHDPE layer shall be substituted with embossed aluminium foil 75 microns thick. Product to be used for cast-in-situ roof slab shall be MULTIPLAS STANDARD or approved equivalent and that for roof with precast slab panels shall be MULTIPLAS ALUMINIUM or approved equivalent.

Bituminous Polymeric Membrane For Underground Damp Proofing.

The membrane used for waterproofing underground structures shall be 7 layered membrane similar to 5 layered roofing membrane, but reinforced with a non woven polyester mat of minimum 140 g/m² for additional mechanical strength and covered with additional layer of polymeric asphalt. Product to be used shall be MULTIPLAS HYPER or approved equivalent.



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Fibre Glass Tissue Reinforced Bitumen Felt

It shall conform to IS:7193, consisting of reinforcing glass fibre base coated on both sides with bitumen modified with thermo-plastic polymers.

Bonding Materials

Bonding materials used for applying the polymeric bituminous membrane on surfaces shall be fibre and solvent based, rubber modified bituminous primer of density 0.92 g/cm³ with viscosity 500 to 10,000 cps.

Bonding materials used for applying the bituminous felts on surfaces shall be industrial bitumen of blown type conforming to IS:702 or residual paving bitumen conforming to IS:73 or a mixture thereof.

Cold applied bitumen shall be homogeneous emulsion of bitumen and plasticizers. The bitumen content shall be more than 35%. When applied it shall remain plastic at 00C

Water Proofing Admixture

The water proofing admixture shall conform to IS:2645 and shall be approved by the Purchaser's Owner.

Cement

Cement shall conform to IS:269.

Aggregates

The aggregates shall conform to IS:383. Fine aggregate shall be river sand or pit sand from approved pits. Coarse aggregate shall be stone chips of size not exceeding 6 mm.

Metal Flashings

Metal flashings shall be of 18 gauge or 20 gauge galvanised iron.

8.4

Workmanship

Waterproofing Of Roof

With Hessian Based Bitumen Felts

The roof slab shall be cleaned of all dust, dirt, grit etc., and if rough, it shall be made reasonably smooth either by chipping of projections or by applying a thin coat of cement slurry of cement, sand and water. The roof surface shall be re-graded prior to waterproofing either with cement mortar or lime-surkhi mortar. At the places of drain outlets, projecting pipes, parapet walls and expansion joints etc. the surface shall be prepared as indicated in IS:1346.

The workmanship in general shall conform to IS:1346 unless otherwise specified. Over the hardened and finished surface of roof slab, a thin layer of approved bitumen primer shall be first brushed over and allowed to dry.

The felt shall be first cut to the required lengths and laid out flat on the roof in position at right angles to the direction of run-off gradient. Each length of felt thus laid in position shall be rolled up for a distance of half of its length. Then the bonding material heated to correct temperature shall be poured on to the roof



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across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The other half shall be then bonded in the same way.

Minimum overlaps of 100 mm shall be kept at the end and the sides of strips of felt. All overlaps shall be firmly bonded with hot bitumen. Laying of successive layers of felt shall be so arranged that the joints are staggered with those of the layer beneath it.

In case of roofs with parapets, a chase 75 mm deep shall be cut in the parapet masonry at about 150 mm above the roof level and the felt shall be laid as flashings in widths with a minimum overlap of 100 mm. The lower edge of flashing shall overlap the felt laid on flat portion of the roof and the upper edge of the flashing shall be tucked into the groove made in the parapet. After the flashings have been properly bonded, the chase shall be cleaned and shall be filled up with cement mortar (1:4) flush with the face of the wall and allowed to set by adequate curing.

In case of drain mouths, waterproofing shall be done as specified for the roof excepting that the treatment shall be carried inside the drainpipes overlapping at least 100 mm.

For gutters, a priming coat shall first be applied. Over this, specified number of layers of felt shall be laid and bonded together with hot bitumen and finally painted with a coat of hot bitumen at not less than 1.5 kg per sq. metre. The felt layers laid separately in the gutters shall be overlapped with the corresponding layers on the roof proper. The felt treatment shall be carried down into the outlet pipes to a minimum depth of 100 mm.

After the treatment is over, the surface shall be covered by pea-sized gravel or grit at the rate of 0.6 cu.m per 100 sq.m. On flashings and at drain mouths a finish of two coats of approved bituminous primer shall be provided.

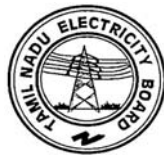
With Polymeric Bituminous Membrane

The roof slabs surface shall be prepared in line with that for hessian based bitumen felt.

Over the hardened and finished surface of roof slab, suitable approved primer such as MULTIPLAS PRIMER or approved equivalent is coated at the rate of 250 g/cm². The waterproofing membrane is unrolled over the coated surface with overlaps of 100 mm and bonded completely to the substrate. The overlaps are then sealed by flame. Installation of the waterproofing membrane shall be strictly as per the manufacturer's instructions and supervision.

Other details shall be the same as those for hessian based bitumen felt.

After the treatment is over, the surface shall be covered with 20 mm plaster of cement mortar (1:4) reinforced with chicken wire mesh, marked off into squares 600 mm wide with expansion joints provided at a distance of 3 metres for cast-in-situ accessible roofs.



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With Fibre Glass Tissue Reinforced Bitumen Felt

Water proofing for roofs shall be according to the guide lines in IS:1346. Other requirements shall be the same as those for hessian based bitumen felt.

For all roof water proofing item of works, the water tightness of the roof shall be tested by filling the roof with 300 mm height of water for 7 days and checking sign of leakage. Further roofing work shall be applied only after the water has been removed and the membrane is completely is completely dry.

With Brick Lime Concrete And Pressed Flat Tiles

The exposed surfaces of the roof slab shall be thoroughly cleaned. A layer of brick lime concrete shall be laid over the cleaned surface. Brick lime concrete shall be 1:2:4 by volume using 20 mm down graded brickbats. The slope of the lime concrete layer shall be 1:100 and the minimum thickness shall be 50 mm. The slope of the draining surfaces shall be formed on all the sides as necessary.

Care shall be taken to check the quantity of water. The quantity of water shall be so as to make the concrete just workable. Cement sand mortar (1:3) with approved water proofing agent shall be laid over the under bed to a thickness of 20 mm. Pressed flat tiles shall be set over the mortar and pointed with the same cement mortar.

Thermal Insulation

The thermal insulation of roof (where required) shall be extruded polystyrene rigid foam boards with a thickness of not less than 50 mm. The material and workmanship shall be as per relevant I.S. code.

Roof drainage

The location, size and the number of rainwater outlet shall be proposed by the contractor and approved by the consultant. The outlet shall be connected to down pipes. Down pipe shall be of suitable size compatible with the outlets and fitted with 450 shoe.

Damp proofing of underground structures

Damp proofing for under ground structures wherever indicated shall be done with hessian based bitumen felts as per recommendations of IS:1609 clause 5.2(b), for heavy treatment, with three layers of felt. The method of laying damp proofing treatment shall be as per clause 6 of IS: 1609.

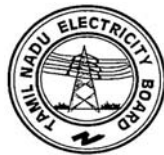
8.5

Acceptance Criteria

The slopes and surface level shall be such as to allow quick draining of water without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The water tightness of the roof shall be tested by ponding the roof with 300mm height of water for 7 days and checking for any signs of leakage.

The Contractor shall furnish a performance guarantee of all the waterproofing treatment for a minimum period of five (5) years.



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9 PLUMBING AND SANITARY INSTALLATIONS

9.1 General

The work under this chapter comprises the supply and installations of the complete plumbing and sanitary system and shall be carried out in compliance with all local rules and regulations for plumbing installation. All material for plumbing and sanitary installation shall be suitable for their intended purpose and appropriately matched to each other. All material and structural components shall be standardised and shall meet the respective quality and dimensional requirements. The Contractor shall submit samples, description, catalogues and/or drawings showing all technical details, type, manufacturer etc. of the offered materials for Consultant's approval.

All plumbing and sanitary works shall be executed by a licensed or authorised plumbing supervisor or a licensed or authorised plumber and shall be in accordance with the requirements of IS:1742 and other relevant codes.

For items such as earthworks, excavation, concrete, brick work, stonework, painting etc., relevant specifications for these shall apply, unless other wise specified.

Unless otherwise specified, all exposed cast iron or mild steel components such as cisterns, brackets etc. shall be painted with one coat of red oxide paint and two coats of oil based paint of approved colour.

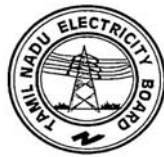
The diameter of pipes and fittings wherever mentioned shall mean the internal diameter or nominal bore, unless otherwise specified.

The job shall include the cost of making necessary chases, holes etc, in walls, floors and in other places and also making good on completion of the works. Any damage caused to floors, walls etc. during execution of the sanitary and plumbing works shall be made good by the Contractor to the satisfaction of the Consultant.

9.2 Standards

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter:

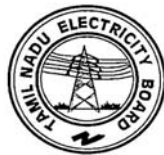
Roof Drainage System	
IS:1230	Cast iron rain water pipes and fittings
IS:1626	Asbestos cement building pipes, gutters and fittings (spigot and socket type)
IS:1729	Sand cast iron spigot and socket soil waste and ventilating pipes, fittings and accessories.
IS:1742	Code of practice for building drainage.
IS:2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage
Pipes and fittings for sanitary plumbing and drainage	
IS:404	Lead pipes (All parts)



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IS:405	Lead sheet and strip (All parts)
IS:458	Precast concrete pipes (with and without reinforcements)
IS:651	Salt glazed stoneware pipes and fittings
IS:771	Glazed fire clay sanitary appliances (All parts)
IS:774	Flushing cistern for water-closets and urinals (other than plastic cisterns)
IS:775	Cast iron brackets and supports for wash basins and sinks
IS:778	Copper alloy gate, globe and check valves for water works purposes.
IS:781	Cast copper alloy screw down bib taps and stop valves for water services
IS:782	Caulking lead
IS:783	Code of practice for laying of concrete pipes
IS:804	Rectangular pressed steel tanks
IS:1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS:1172	Code of basic requirement for water supply, drainage and sanitation
IS:1239	Mild steel tubes and tubulars and other wrought steel fittings (All parts)
IS:1536	Centrifugally cast(spun) iron pressure pipes for water, gas and sewage
IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS:1703	Copper alloy float valves (horizontal plunger type) for water supply fittings.
IS:1711	Self closing taps for water supply purposes.
IS:1726	Cast iron manhole covers and frames.
IS:1729	Sand cast iron spigot and socket soil waste and ventilating pipes, fittings and accessories.
IS:1742	Code of practice for building drainage
IS:1795	Specification for Pillar taps for water supply purposes
IS:2064	Selection, installation and maintenance of sanitary appliances - Code of practice
IS:2065	Code of practice for water supply in buildings
IS:2104	Specification for Water meter boxes (domestic type)
IS:2326	Automatic flushing cisterns for urinals (other than plastic cisterns)
IS:2470	Code of practice for installation of septic tanks (All parts)
IS:2548	Plastic seats and covers for water-closet
IS:2556	Vitreous sanitary appliance (vitreous china) (All parts)
IS:2963	Specification for Copper alloy waste-fittings for wash basins and sinks
IS:3004	Specification for Plug cocks for water supply purposes
IS:3006	Specification for chemically resistant glazed stoneware pipes and fittings
IS:3076	Low density polyethylene pipes for potable water supplies



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IS:3114	Code of practice for laying of cast iron pipes
IS:3311	Waste plug and its accessories for sinks and wash basins
IS:3486	Cast iron spigot and socket drain pipes
IS:3597	Methods of test for concrete pipes
IS:4127	Code of practice for laying of glazed stoneware pipes
IS:4346	Specification for washers for use with fittings for water services
IS:4984	High density polyethylene (HDPE) pipes for potable water supply
IS:4985	Specification for Unplasticized PVC pipes for potable water supplies
IS:5219	Cast copper alloy traps: Part 1, 'P' and 'S' traps
IS:5329	Code of practice for sanitary pipe work above ground for buildings
IS:5961	Specification for Cast iron gratings for drainage purposes
IS:7634	Code of practice for plastic pipe work for potable water supplies (All parts)
IS:8008	Injection moulded high density polyethylene (HDPE) fittings for potable water supplies (All parts)
IS:10124	Fabricated PVC fittings for potable water supplies (All parts)
IS:10592	Industrial emergency showers, eye and face fountains and combination units

9.3 Materials

Sanitary Fittings

All sanitary fittings shall be procured from approved vendors and shall conform to the requirements of the relevant IS Codes listed above. The sizes shall be as specified in the drawings and where not specified, the same shall be as per Consultant's approval.

Glazed earthenware fittings shall be of reputed make, white colour and one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be of Chromium Plated (CP) brass of approved make. All wall fittings shall be fixed with wooden cleats and CP brass screws and washers.

Pipes And Fittings

Cast iron pipes and specials shall be of standard quality conforming to IS:3486.

Stoneware pipes shall conform to IS:651.

RCC pipes for underground sewer shall be P1 class conforming to IS:458.

Cast Iron rain water pipes shall conform to IS:1230.

Mild steel pipes shall conform to IS:1239

Water supply lines of GI, PVC, HDPE shall conform to IS:1239, IS:4985 and IS:4984 respectively. PVC fittings for water supply lines shall conform to IS:10124.



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9.4

Installation

All execution will be done on the basis of approved drawings / instructions given by the Consultant. Fittings shall be located and oriented to allow easy reach such that operation, maintenance, repairs and replacements of pipes, fittings and fixtures are conveniently possible.

Cast Iron / Stoneware Pipes For Soil And Waste Pipe Line

The laying of cast iron / glazed stoneware pipelines shall commence only after the bottom of the trench at various points have been levelled and aligned in accordance with the drawings. When the pipeline has to be laid above ground by the side of wall, it shall be securely fixed to the wall with clamps, wooden plugs and nails. The type of jointing for pipes shall be socket and spigot type.

Cast Iron Rainwater Pipes

Cast iron rainwater pipes fixed to the external walls shall be blocked out at least 20 mm from the plastered surfaces by means of cast iron bobbins. The rainwater pipes at the roof level shall be fitted with a cast iron bend with a masonry bell mouth of suitable size fitted with a cast iron grating. The bottom of the down pipe shall be fitted with a shoe fixed 150 mm above ground / apron level of the building. The socket and spigots of pipes and fittings shall be jointed as specified for cast iron soil and waste pipe line.

Galvanised Steel Water Supply Pipes

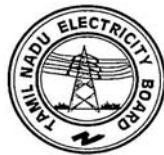
Screwed galvanised steel pipes shall be jointed with screwed joints and screwed fittings of the same materials as that of the pipes. Any burrs remaining on the pipe ends after the threads are cut, shall be removed. An approved jointing compound together with a grommet of a few strands of fine yarn shall be used for jointing pipes and fittings. Any pipe threads exposed after jointing shall be painted, or in the case of underground piping, thickly coated with approved bituminous compound to prevent corrosion.

The depth at which the underground water supply pipe is to be laid shall be as shown on the drawings. The service pipe passing into or beneath the building shall be laid at least 200 mm below the ground floor level and accommodated in a previously laid sleeve in the structure where it enters the building. The space between the sleeve and the pipe at its entry into and exit from the building shall be filled with approved bituminous sealing material for a minimum of 150 mm at both ends.

Piping shall not be buried in walls or floors as far as possible. However, when unavoidable, piping shall be buried for the shortest distance necessary and adequate protection shall be provided against damage. Galvanised steel piping shall be secured by iron or steel clamps and hooks when fixed on walls.

All pipework shall be completely watertight and the joints shall be such that there are no projections of jointing materials or the like in the interior of pipes. Before the pipeline is commissioned, all piping and fittings shall be flushed clean.

High Density Polyethylene Water Supply Pipes



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All high density polyethylene pipes shall have screwed ends and shall be jointed with screwed fittings of the same materials as that of the pipes. Any burrs remaining on the pipe ends after cutting threads shall be removed. If necessary, an approved jointing compound with a few strands of fine yarn may be used for jointing pipes and fittings. All exposed high density polyethylene pipes shall be installed with PVC saddles screwed on 25 mm thick wooden blocks securely fixed on walls at suitable intervals, not exceeding 1.0m. Pipe wherever installed in wall chasing, shall be fixed as in the case of galvanised steel pipes.

PVC Water Supply Pipes

All exposed pipes shall be installed with PVC saddles screwed on 25 mm thick wooden blocks securely fixed on walls at suitable intervals, not exceeding 1.0m. Pipe wherever installed in wall chasing, shall be fixed as in the case of galvanised steel pipes.

9.5

Sanitary Appliances

All sanitary appliances shall be fixed in position rigidly on floor and walls as indicated in the drawings or as directed by the Consultant. All appliances shall be from the approved manufacturer and of approved colour.

Indian Water Closet (IWC) - Squatting type

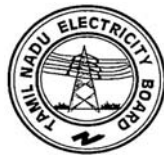
Squatting type water closet shall be fitted on trap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be levelled properly and set flush with the finished floor. The pan shall be connected to PVC low level push button / lever type cistern of 10 litre capacity. The flushing cistern shall be supported on a pair of CI cantilever brackets firmly embedded in the wall in cement mortar (1:4) or screwed to wall with suitable plugs. The flush pipe from the cistern shall be 32mm dia tested quality chromium plated (CP) pipe and connected to the pan inlet by means of hemp and putty joint.

European Water Closet (EWC) - Pedestal type

Pedestal type water closet shall be rigidly fixed on the finished floor by means of 75mm long brass screws with suitable plugs. The flushing cistern shall be PVC low level push button / lever type cistern of 10 litres capacity. The cistern shall be supported on a pair of cast iron or rolled steel cantilever brackets firmly fixed on wall with brass screws and suitable plugs. The flush pipe from the cistern shall be 40mm dia chromium plated with brass end cap / lining and fitted to the closet by means of rubber adapter. The closet shall be provided with double plastic seat cover conforming to IS:2548 with chromium plated hinges.

Urinals

Standing type urinals shall be firmly fitted on finished wall by means of 50mm long brass screws and suitable plugs. Height of the lip from the standing point shall be as shown in the drawings. Urinals shall be fitted with automatic flushing cistern of 10/15 litres (2/3 urinals) capacity. Flushing pipes shall be of CP pipes of 25mm dia and connected to the urinal with 15mm dia PVC connector fitted with brass cap and lining at one end. The joint to the inlet of urinal shall be neatly finished with putty.



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The arrangement of waste pipes and discharge to the floor trap shall be as shown on the drawings or as directed by Consultant. For single urinal, the discharge may be directly to the floor trap through a 40mm dia waste pipe. For a range of urinals, the discharge may be collected in a common waste pipe of 50mm dia leading to the floor trap. Each urinal shall be connected to the common discharge pipe by 40mm dia waste pipes. Alternatively, the discharge from each urinal through 40mm dia pipe shall be lead to the 100 mm glazed stone ware / vitreous china / CI half round channel laid on the floor leading to the floor trap.

Wash basin

Wash basin shall be fitted in position true to level on a pair of cast iron brackets fixed to the wall with brass screws and plugs. The basin shall be fitted with 15mm dia approved quality CP pillar tap and 32 mm dia waste fittings. The type of waste pipe and their connections shall be as shown in the drawings or as directed by the Consultant.

Sink

Stainless steel sink shall be levelled properly and fitted in position on a pair of cast iron cantilever brackets firmly embedded in the wall in cement mortar (1:4). The sink shall be fitted with chromium plated brass waste fittings of standard size. The type of waste pipes and their connections shall be as shown on the drawings or as directed by the Purchaser's Owner.

Other miscellaneous fittings (e.g. mirror, towel rails, soap cases etc.)

All such fittings shall be of type and sizes specified in General Technical Specification / Specific Technical And Functional Requirements Of Civil Systems, and shall be fitted in position true to line, level and plane as shown on the drawings or as directed by the Consultant.

Water Tanks

Water storage tanks shall be food grade PVC tanks of SINTEX brand or approved equivalent make, unless otherwise specified.

In case large volume tank is to be constructed, the same shall be of GI, Masonry or RCC. They shall be fitted with a ball valve of the inlet pipe. A mosquito proof overflow pipe shall be fixed to the tank with the pipe invert about 25 mm above the top of water line. Approved type of stop valve shall be provided for every outlet pipe. All outlet and inlet pipes shall be fixed as shown in the drawings. Inside surface of galvanised steel tanks shall be painted with anti-corrosive food grade paints.

All storage tanks, water supply fittings and pipes, before being put into commission, shall be disinfected with liquid chlorine by the Contractor.

9.6

Testing And Acceptance Criteria

Sanitary Appliances

All sanitary appliances and fittings shall be inspected and tested as per the requirements of IS:1742. All defects and deficiencies detected shall be promptly rectified by the Contractor to the satisfaction of Consultant.



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Soil And Waste Pipeline

On completion of laying, the cast iron soil, waste and ventilation pipelines shall be tested by the Contractor to detect leakage and any other defects in the pipelines.

Test shall be conducted using proper apparatus with attachment for smoke making machine for applying smoke to the pipelines under pressure. Only cotton waste or brown paper soaked in creosote oil shall be used and fired to obtain dense and pungent smoke. While conducting smoke test, top of soil, waste and ventilation pipes shall be kept open till smoke starts coming out of the openings. The openings shall then be securely plugged with expanding rubber or any other approved plug. The floor traps and other openings for connecting sanitary fixtures shall be sealed with water or other approved plug. The entire pipeline shall be tested in suitable sections as directed by the Consultant. The entire length of the pipelines including all joints under test shall be closely observed for any sign of smoke leakage.

Galvanised Steel Water Supply Pipes

After the laying and fixing of all galvanised steel water supply pipes and fittings are completed, the line shall be slowly and carefully charged with water to a test pressure of 5 kg per sq. cm or the specified working pressure plus 50%, as may be prescribed by the Consultant. Care shall be taken that air in pipelines is completely exhausted while filling the pipelines with water. This pressure shall be maintained for at least one hour, unless otherwise specified.

10 METAL WORK

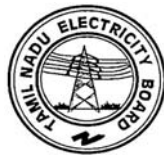
10.1 General

This chapter covers the various metal works such as, Rolling shutter, grills, steel doors, aluminium doors and windows, ventilators, Louvers, suspended ceilings, roof and wall cladding etc.

10.2 Standards

Unless otherwise specified herein. The following standards shall apply to the works covered by this chapter.

IS:733	Wrought aluminium and aluminium alloy bars, rods and sections (for general engineering purposes)
IS:737	Wrought aluminium and aluminium alloy sheet and strips for general engineering purposes.
IS:1038	Steel doors, windows and ventilators
IS:1361	Steel windows for industrial buildings
IS:1948	Aluminium doors, windows and ventilators
IS:1949	Aluminium windows for industrial buildings.
IS:3614	Specification for fire check doors
IS:4351	Specification for steel door frames
IS:6051	Code for designation of aluminium and its alloys.
Rolling Shutters	
IS:2108	Blackheart malleable iron castings



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IS:6248	Specification for metal rolling shutters and rolling grills
Glazing	
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
IS:2835	Flat transparent sheet glass
IS:3548	Code of practice for glazing in buildings
Builder's Hardware	
IS:204	Tower bolts (All parts)
IS:205	Non-ferrous metal butt hinges
IS:208	Door handles
IS:281	Mild steel sliding door bolts for use with padlocks
IS:363	Hasps and staples
IS:723	Steel countersunk head wire nails
IS:1823	Floor door stoppers
IS:2209	Mortice locks (vertical type)
IS:2681	Non-ferrous metal sliding door bolts for use with padlocks
IS:3564	Hydraulically regulated door closures
IS:3847	Mortice night latches
IS:4992	Specification for door handles for mortice locks (vertical types)
IS:6607	Specification for rebated mortice locks (vertical type)

10.3

Flush Steel Doors

General

Steel doors and pressed frames shall be made of 18g steel sheets. Frames shall conform to IS:4351

No joints shall be permitted in the steel sheets.

All steel doors shall be double-skinned construction with all necessary reinforcement for hinges, locks and other fixtures. The two skins of 18g minimum thick steel sheets shall be mechanically interlocked and bonded together to form an envelope, which shall be closed at the top and bottom with two steel channels, welded to the steel sheets.

Mineral wool or equivalent material approved by the Consultant shall be provided as insulation over the whole interior area of the door and shall be fixed with a plastic binder such that no part of the door may become uninsulated due to shocks, blows or long and repeated use of the door.

All doors shall be fitted with necessary best quality hardware and fixtures conforming to relevant IS specifications and shall be capable of withstanding repeated use.

Three steel butt hinges of 100 mm length shall be provided for each door leaf.

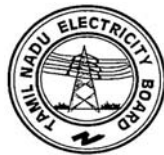
Steel frames shall be fixed to the masonry by steel sleeve anchor bolts M12 mm passing through holes of 25 mm diameter in the frame. Steel frames shall be fixed to the steel structure by screws.

The clearance of doors shall be 2.5 mm at jambs and heads

Steel frames shall be provided with door closer fitted with rubber cushions.

External doors shall have an external weather stop.

All fire exit doors shall be provided with panic latch system with horizontal bar action parallel to the door face moving in the direction of the door travel to provide



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immediate exit in the event of fire or emergency whilst providing security against unauthorised entry.

Sign plates of anodised aluminium or galvanised steel shall be screwed to the door under the horizontal bar, on which the sign, "PUSH BAR TO OPEN" shall be printed.

The thickness of the normal steel door shall be 45 mm for both single and double doors.

All the above specified details shall be applied for normal steel doors, fire resistant steel doors and fire proof steel doors.

The contractor shall provide the Consultant with following documents for the steel doors:

- Detailed shop and construction drawings as well as the door schedules and samples of hardware.
- Detailed structural analysis of the proposed supplies.
- Test certificates proving conformity of the physical properties stipulated in this specification and relevant standards

10.4 Fire Resisting And Fire Proof Doors

Fireproof doors with panic devices shall be provided at all fire exit points as per recommendations of Tariff Advisory Committee (TAC). These shall conform to IS:3614 (Part I and Part II). Fire rating of doors shall be as per TAC requirement. However, minimum requirement shall be for two hours. Type of doors shall be double cover-plated type with mineral wool insulation.

10.5 Rolling Shutter (Hand Operated, Mechanical Gear Operated And Electrically Operated) and Grills

Rolling shutters shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108. They shall be designed to withstand a wind load of 200 Kg/m² without excessive deflection.

The guides shall be either rolled or pressed deep channel sections 75 mm and 25 mm wide fitted with necessary fitting and fixtures.

The suspension shaft shall be formed from heavy duty tubes conforming to IS:1161 and of sufficient diameter so as to resist deflection due to weight of the rolling shutter. The deflection shall not exceed 5mm / metre width. The shaft shall be provided with CI pulleys and helical springs for counter balancing the weight of the shutter adequately.

The springs shall be approved high tensile flat springs conforming to Grade 2 of IS:4454. These shall be fitted inside the fabricated housing at either ends, which counter-balance the shutter curtain.

The ball bearings shall be double row self-aligning ball bearings fitted inside CI housing fixed on side brackets holding the suspension shaft at either end. The roller assembly shall be designed so as to be capable of producing sufficient torque to ensure easy operation of the rolling shutter in any position. The spring tension shall be adjustable by means of suitable adjustment holes drilled on the rims of the pulley.

The hood cover shall be made of 20 gauge sheets with necessary stiffeners and framework to prevent sag. The bottom lock plate shall be made of 5 mm thick



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M.S. plate and 95 mm wide, reinforced with angle/T iron of suitable section with 6 mm dia M.S. rivets interlocked with last stride of curtain.

The locking arrangement shall consist of sliding bolts at both ends of the bottom plate fitted to engage with suitable receiving pockets at the bottom of guide channels.

Unless otherwise specified, for overall area of rolling shutters up to 9 sq.m, pull and push type hand-operated shutters shall be used. For area between 9 and 12 sq.m, pull and push type shutters shall be provided with ball bearings. For area larger than 12 sq.m mechanical gear type or electrically operated shutters shall be supplied.

Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

10.6

Folding Steel Doors

The folding doors shall be used for the entrance of machine halls, workshops and similar. The unit shall be manufactured as a top hung folding door of edged steel sheets and steel sections. Clear height of the pass-gate shall be not less than 2.00 m.

Door leaves shall be manufactured with double flush skin of steel sheet, min 1.5 mm thick, edged and welded to the case. The case shall be stiffened with steel section frame. Thickness of the leaves shall not be less 60 mm.

The door shall be constructed for one way normal manual usage under subtropical conditions for exterior openings in accordance with the architectural design.

The insulation material inside the door shall be fire resistant.

The fixing of the door frame to the wall or steel structure shall be carried out by means of flat steel anchors, size not less than 250/40/4 mm and steel bolts, dia. 8 mm, either cemented into the wall or screwed to the steel structure.

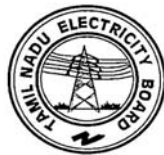
Three anchors shall be provided per 2.5 m length with a minimum of six (6) anchors per door frame.

Joints between doorframe and construction shall be sealed with permanent elastic compound where the door has to be fixed to steel structure.

The door shall be furnished with heavy sturdy-built hardware of corrosion protected steel consisting of:

- truck brackets
- intermediate hinges with nylon washers
- hangers with nylon wheels, ball bearing, lubricated for life incl. wheel centre pattern
- flush handles outside
- fold-aside butt hinges, min. three (3) per 2.5 m length
- door guides with end and centre pattern
- floor channel
- furniture, bolts and screws with all fittings

The door and frame shall be galvanised and coated by epoxy paint over galvanizing.



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10.7 Steel Windows and Ventilators

These shall conform in all respects to IS: 1038, IS:7452 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified under Schedule of Items. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

10.8 Aluminium Doors, Windows, Glass Walls and Louvers

Aluminium sections for doors, windows and glass walls shall comply with IS:1948 and IS:1949.

Aluminium doors, windows and glass walls as well as aluminium frames shall be anodised in accordance with relevant Indian Standards.

All hardware shall be of concealed construction in the aluminium frame and shall be made of stainless steel. Sections of aluminium profiles shall not be less than 50 mm deep.

All doors shall be provided with door closer, door stops.

Aluminium alloys shall be of uniform quality, free from defects impairing strength and durability with regularity of surfaces and accuracy of right angles.

Aluminium windows at high levels shall be fitted with mechanical devices of type approved by the Consultant to allow for opening of such windows from the ground level.

Marble sills of 30 mm thickness shall be installed under the windows.

Door and window elements shall be fixed to the structure by means of separate rectangular hollow galvanised steel or aluminium frame.

Joints of door and window frames to the walls shall be covered with aluminium angle on each side and they shall be sealed with permanent elastic material in accordance with the manufacturer's instructions. For air-conditioned rooms, the aluminium windows shall have double glazing.

The Contractor shall provide the following documents for all aluminium profile constructions:

- Detailed shop and construction drawings including the doors and windows schedule
- Detailed structural analysis of the proposed supplies
- Test certificates proving the conformity of the physical properties stipulated in the specifications and the relevant Standards stated herein



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10.9

Master Key System

An appropriate serviceable and functional master key system for the whole plant shall be installed. The elaboration of the system itself shall be made in close co-ordination with the Purchaser /Consultant and only after obtaining the Purchaser's/Consultant's approval in writing shall the order of production be placed.

The following requirements shall be met:

- the general master key shall operate all locks
- the main key shall open all locks of one building
- the single key shall open the lock of a single room.

Necessary attention shall be paid to later extensions of the master key system, which shall be suitable for the entire plant including all final stages.

The profile cylinders shall be sea water resistant and shall suit all plant requirements. The material of the cylinders shall be of massive brass, nickel-plated with six security pawl studs.

The keys shall be made of material approved by the Purchaser / Consultant and shall have an engraved indication of the applicable key system and the building or door number.

Keys shall be supplied in the following numbers:

General master key	10	
Main keys	10	nos. per each building
Single keys	3	nos. per each door

10.10

Suspended Ceilings

Suspended ceilings shall be provided for control rooms, offices, conference rooms, corridors, etc.

The panels shall be 0.8 mm thick, stove enamelled, aluminium sheets

In general the size of the panels shall be 600 mm x 600 mm. Panels of closed appearance of 75 mm or 150 mm wide and length up to 6 meters could be used as directed by the Purchaser / Consultant.

The suspension system shall be of sufficient strength and rigidity to carry the panels.

The panels shall be supported by stove enamelled aluminium panel carriers.

The rod hangers shall be made of galvanised steel of 4 mm diameter (minimum).

The joints between the panels and the light fixtures and air supply ducts shall be smooth and regular.

Power driven fasteners shall be used for fixing the rod hangers in the reinforced concrete ceiling.

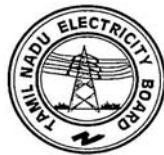
10.11

Room Designation Signs

The entrance to each room shall be furnished with a room designation sign on an anodised aluminium plate of 4mm thickness

Four horizontal grooves of 10 mm width at the lower end of the sign plate shall take plastic strips on which the designation will be printed in English language. At the upper portion the room number shall be engraved with a black background.

The designation sign plates shall be screwed to the wall with non-corroding screws.



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10.12 Roof And Wall Cladding System

General

All structural steel buildings shall have insulated sandwich cladding or single uninsulated cladding for roofs and walls, depending upon the requirement. The Contractor shall provide the Purchaser / Consultant with five (5) years guarantee of the roof and wall cladding.

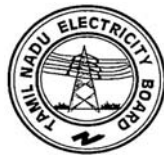
Coating System

The roof and wall cladding shall be a multi-layered protected metal system consisting of a galvanised steel substrate, heavy epoxy base coat and a high build exterior weather coat of polyurethane as follows:

Substrate:	Hot-dipped galvanised steel, conforming to B.S.E.N 10143 Type G275, with a minimum zinc coating weight of 275 g/m ² total both sides.
Pre-treatment:	After cleaning, a chemical conversion of the zinc coating to a non-metallic surface with corrosion inhibiting and adhesive additives.
Primer:	Nominal 15 micron thick anti-corrosive pigmented epoxy primer applied to both sides.
Epoxy Barrier Coat:	Nominal 50 micron thick epoxy barrier coat applied to both sides and baked to a hard corrosion resistant finish.
External Weather coat:	40 microns thick polyurethane exterior coating of approved colour
Internal Decorative Coat:	A stoving polyester in approved colour.
Finish:	All sheets shall have an embossed finish.

The roof and wall cladding shall meet the following performance criteria:

Classification	Test	Minimum Performance	Test
Physical and Environmental:	Humidity Resistance ASTM D-2247	No effect	
Chemical and Environmental:	Abrasion Resistance(falling sand method ASTM D-968)	375 litres of sand	
	Coating System Integrity (Salt Fog : ASTM B117)	No effect	



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The above performance criteria shall be substantiated by test results certified by recognised independent testing authority.

Insulated Sandwich Cladding

The insulated roof and wall cladding shall be formed from trapezoidal sheeting and shall meet all specified design criteria.

Roofs

External Roof	: Profile	: Trapezoidal
Weather Sheet	Thickness	: 0.70 mm
	Depth	: 38 mm
Internal Roof	: Profile	: Trapezoidal
Sheet	Thickness	: 0.95 mm
	Depth	: 61 mm

Loadings : The cladding system shall be suitable for the loadings and shall meet the following criteria

Deflection	: Roof area	1/200 of span, except where roof slopes are below 5 degrees when the limiting deflection shall be 1/300 of the span

Walls

External wall	: Profile	: Trapezoidal
Weather sheet	Thickness	: 0.70 mm
	Depth	: 38 mm
Internal Wall	: Profile	: Trapezoidal
Sheet	Thickness	: 0.95 mm
	Depth	: 61 mm

The internal liner shall be formed from a trapezoidal galvanised sheet; the exposed face shall be painted.

Deflection : Wall area – 1/120 of the span.

Subgirts : 1.5 mm thick 'Z' type galvanised subgirts shall be employed to create a space to accommodate the specified thickness of the insulation. The location of the subgirts shall be such that the external weathering sheets shall meet the specified design loads.
The male side lap joints shall be sealed on site with suitable preformed mastic sealant.

Insulation : Mineral wool lightweight rolls conforming to the requirements of IS 8183 shall be fitted into the space created by the subgirts.

Thickness : 80 mm

Density : 24 kg/m³

Thermal : 0.40 w/m²K

Conductivity

Acoustic Requirements Of The Roof And Wall Cladding Constructions

The roof and wall cladding shall provide an acoustic attenuation factor through the construction of at least between R'_w = 36 - 40 dB



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Translucent Sheeting

Translucent sheeting shall be provided where required and fixed to the walls, located in continuous bands, comprising of two skins translucent sheeting supplied to match and overlap the specified external and internal profiled metal cladding and manufactured as follows:

Polyester resin reinforced with chopped-strand glass fibre mat and made in a continuous process generally in accordance with IS Standards. A film of tedlar polyvinyl flouride or melinex polyester is bonded chemically to the external weathering surface. Flashing and accessories to be provided.

Light transmission: approx. 60-65% for clear skins

End Laps

External weathering sheet:

Where the angles of the roofs are 7 degrees or below, the end laps shall be a minimum of 200 mm. On roof slopes in excess of 7 degrees, the end laps shall be a minimum of 150 mm.

On vertical areas the end laps shall be a minimum of 100 mm.

Internal liners:

End laps shall be 75 mm on the trapezoidal internal liners; the tray shall be butt-jointed.

Sealant

The cladding shall be sealed with a non-drying, non-corrosive permanently elastic pre-formed metal sealing tape capable of performing in a temperature up to 1000°C.

Fixings

The external weathering sheet shall be secured to the galvanised subgirts or structural supports with stainless steel hexagon headed self-tapping screws, each with a integral EPDM (Ethylene Propylene Die Memonoma) washer bonded to a dished aluminium washer. The internal liners shall be secured to the supporting steel structure with galvanised self-tapping screws. Galvanised subgirts dependant on their type shall be secured with galvanised self-tapping screws or rivets.

Side lap fixings shall be blind rivets.

The cladding supplier shall submit calculations, which substantiate that his fixing allowances will meet the design loads.

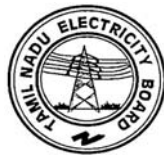
Flashings

Flashings required in connection with the external weathering skin shall be formed from 0.70 mm thick material as specified for the roof and/or side wall cladding.

Flashings required in connection with the internal liner shall be constructed from 0.70 mm thick galvanised steel having a painted finish on the exposed face.

Corrugation Fillers

Profiled filler pieces shall be provided at all terminal positions on the roof and side wall areas. The fillers shall be of polyethylene foam and be immune to bird and insect attack.



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Gutters / Rainwater Pipes

Design procedures shall be based on appropriate Indian Standards. The materials shall be either aluminium or zinc of suitable gauge, and the appliances and components shall comply with the requirements of the applicable Indian Standards.

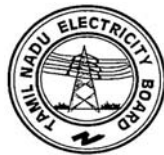
Single sheet uninsulated roof and wall cladding

The roof and/or side wall uninsulated cladding shall be a trapezoidal profiled metal sheeting, protected on both sides by a multi-layer coating system, and shall meet all specified design criteria.

Roof Sheetting	:Thickness	: 0.95 mm
	Depth	: 61 mm
Wall sheetting	:Thickness	: 0.70 mm
	Depth	: 38 mm

Loadings :The cladding system shall be suitable for the loadings and shall meet the following criteria

Deflection	: Roof area	1/200 of span, except where roof slopes are below 5 degrees when the limiting deflection shall be 1/300 of the span
	Wall area	1/200 of the span
End laps	:	Where the angles of the roofs are 7 degrees or below the end laps, shall be a minimum of 200 mm. On roof slopes in excess of 7 degrees, the end laps shall be a minimum of 150 mm On vertical areas the end laps shall be a minimum of 100 mm
Sealants	:	The cladding shall be sealed with a non-drying, non-corrosive permanently elastic preformed metal sealing tape capable of performing in a temperature up to 1000 deg C.
Fixings	:	The cladding shall be secured to the structural steel supports with stainless steel hexagon headed self-tapping screw. Each complete with an integral EPDM washer bonded to a dished aluminium washer. Side lap fixings shall be blind rivets. The cladding supplier shall submit calculations which substantiate that his fixing allowances will meet the design loads.
Flashings	:	Shall be formed from 0.70 mm thick material as specified for the roof and/or side wall cladding.
Corrugation Closures	:	Profiled filler pieces shall be provided at all terminal positions on the roof and side wall areas the fillers shall be of polyethylene foam and be immune to bird and insect attack.



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The roof and wall cladding shall be supplied from reputed manufacturer and suppliers subject to the Purchaser's/Consultant's prior approval.

11 MISCELLANEOUS METAL & ALLIED WORKS

11.01.00 Scope

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, edge angles, inserts, pipe sleeves, stair nosing, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Owner. The above items shall be of fabricated or cast M.S/ Aluminium/ Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described in the Schedule of Items.

11.02.00 Installation

11.02.01 Fabrication/Casting

a).General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

b). Shop Connections

i) All shop connections shall be riveted or welded except when noted otherwise on drawings.

ii) Welding of steel shall be done in accordance with the IS : 816. Use of metal arc welding for general construction in Mild Steel.

iii) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Owner.

c).Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified in Schedule, steel work shall be galvanised or galvanized and painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry



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shall be given one coat of zinc chromate primer.

11.02.02 *Erection*

a) Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

b) Temporary Bolting-Up

As erection proceeds the Contractor shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

c) Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

d) Welding

Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys.

e) Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Owner. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Owner.

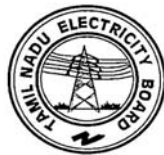
f) Drifting

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Owner and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

g) Grouting

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Owner's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.



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h) Anchor Bolting

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Contractor shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

i) Pipe Joints

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

j) Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint or equivalent.

k) Making Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Owner.

11.03.00 Acceptance Criteria

a) All items shall be of correct shape, size, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be follows :

i) Permissible deviation from straightness - 1 in 1000.

ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blow holes, cracks and other blemishes.

11.04.00 I.S. Codes

IS : 226 - Structural Steel (Standard Quality)

IS : 800 - Code of practice for use of structural steel in general building construction.

IS : 816 - Use of metal arc welding for general construction in mild steel.

IS : 2812 - ARC WELDING OF ALUMINIUM AND ALLOYS

IS : 3150 - HEXAGONAL WIRE NETTING

IS:4948 - Welded steel wire fabric for general use.

12 **JOINERY**

12.1 General

This chapter covers the joinery for permanent works i.e. excluding formwork, shuttering and wood scaffolding.



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12.2

Standards

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter.

IS:399	Classification of commercial timber and their zonal distribution.
IS:303	Ply wood for general purpose.
IS:451	Technical supply conditions for wood screws.
IS:723	Steel countersunk head wire nails.
IS:883	Code of practice for designing of structural timber in buildings.
IS:1003	Timber panelled and glazed shutters.
IS:2191	Wooden flush door shutters (cellular and hollow core type).
IS:2202	Wooden flush door shutters (solid core type).
IS:2366	Code of practice for nail jointed timber construction.
IS:4021	Timber door, windows and ventilator frames.

12.3

Material

Timber for joinery

All timber shall be best quality well seasoned specified wood free from large or loose knots, crack or other defects complying with relevant Indian standards. Hardwood shall be properly seasoned and free from brittle heart, rot, stain and beetle attack.

Plywood

Plywood shall comply with IS:303. The thickness of plywood shall be 6 mm.

Screws and nails

Screws shall be stainless steel or brass. All nails for external permanent work shall be sherardised steel. Screw and nails shall comply with Indian Standards.

Timber Doors

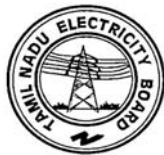
All doors shall be of solid core with minimum thickness of 44mm. The core shall consist of fully glued laminboard / block board of reverse straight grain timber strips each of which shall be continuous through the height of the door except for 150 mm rails top and bottom. The core shall be planed true overall to receive plywood facing.

All doors shall have 150 mm 1st class hardwood rails for the full thickness and width of core as well as around all openings to cover the end grains of the laminboards. The plywood facing on both sides shall be well matched teak or commercial 3 ply veneering with vertical grains or cross bands having minimum thickness of 6 mm as per requirement. Hardwood lipping of the same timber as the face veneer shall be provided at all edges of the door as well as to the opening for glazing.

All doors shall be covered by natural veneer.

Doorframes shall be minimum 50mm thick and 125 mm wide. They shall be fixed to the RCC / masonry frames around the door by screws / holdfasts (MS strip lugs) and shall be provided with adequate rubber sealing. The minimum number of fixtures shall be five screws or three holdfasts on each side of the frame. Holes for screws shall be drilled with a rotary drill and filled with wooden plugs, rawl plugs or hold fasteners.

Clearance of doors shall be 3 mm at jambs and heads.



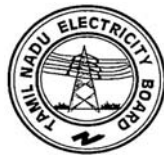
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All hardware shall be heavy duty of non-corroding materials (stainless steel / anodised aluminium / oxidised copper / brass).

Each door leaf shall be furnished with the following:

- 3 hinges preferably 140 mm high pivoted with ball bearings
- 1 heavy door lock with profile cylinder for master-key system
- 2 stainless door level handles of 125 mm
- 2 stainless door handle plates or roses
- 1 door stop sealed with PVC or rubber strips to reduce impact sound
- Toilet room doors shall be provided with automatic door closer.



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13 GLAZING

13.1 General

This chapter shall apply to all parts of the works in which glazing will be used.

13.2 Standards

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter.

IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) door, window and ventilators.
IS:2553	Safety glasses.
IS:2835	Flat transparent sheet glass for glazing and framing purposes.
IS:3548	Code of practice for glazing in buildings.

13.3 Acoustic Requirements

The glazing shall provide an acoustic attenuation factor according to the functional requirement and as per relevant Indian Standards.

13.4 Materials

General

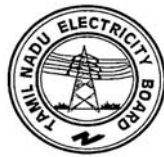
The thickness and type of the glass should meet the acoustic requirements, serviceability and adequacy to the purpose of the glazing. The minimum thickness of glass of the various types shall be 5 mm for openings of areas of less than two square meters, and 6mm for openings of areas of two square meters and more. All air-conditioned rooms shall have double glazing. The Contractor shall submit samples of each different type of glass to the Consultant for approval. Unless otherwise specified herein the types of glass shall comply with IS:2553 and IS:2835.

Solar control glass

Solar control glass shall be formed from two panes of glass bonded together with a lamination between them of thin metallic film vacuum deposited on the inner surface of one of the panes in accordance with relevant IS standards.

Wired glass

Wired glass shall be polished on both sides and shall be transparent, complying with IS:5437. It shall be square pattern wired. The wired glass will be used for doors and windows etc. and also used in fire resistant doors of up to 30 minutes resistance.



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Multiple glazing units

Multiple glazing shall be formed from two or more panes of glass separated by a profiled aluminium spacer with the complete periphery of the unit sealed by the application of a highly impervious moisture vapour resistant polysulphide material.

Multiple glazing with solar control

Multiple glazing with solar control shall have the same properties as multiple glazing units except the inner pane shall be clear float glass and the outer pane solar control glass.

Putty

Putty for glazing to wood shall be linseed oil putty in accordance with relevant IS standards.

13.5 Execution Of The Work

Glazing and fixing techniques for glass, handling and care on site shall be generally in accordance with IS:3548. Outer glazing shall be rain-proof. For metal and aluminium frames, structural U-channel gaskets of synthetic rubber (neoprene) shall be use as sealing strips.

14 PAINTING

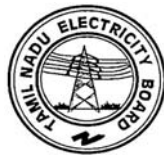
14.1 General

This chapter covers the preparation of surfaces, application of paints and making good any defects. Unless otherwise specified herein, the procedures and workmanship of painting shall be carried out in accordance with relevant IS codes.

14.2 Standards

Unless otherwise specified hereinafter, the following standards shall apply to the works covered by this chapter.

White washing, colour washing and distempering	
IS:427	Distemper, dry, colour as required.
IS:428	Distemper, oil emulsion, colour as required.
IS:6278	Code of practice for white washing and colour washing.
Painting	
IS:5	Colours for ready mixed paints and enamels.
IS:102	Ready mixed paint, brushing, red lead, non-setting, priming.
IS:123	Ready mixed paint, brushing, finishing, semigloss, for general purposes.
IS:1477	Code of practice for painting of ferrous metals in buildings.
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.
IS:2338	Code of practice for finishing of wood and wood based materials.
IS:2339	Aluminium paint for general purposes in dual container.



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IS:2395	Code of practice for painting concrete, masonry and plaster surface.
IS:2932	Enamel, synthetic, exterior, a) undercoating, b) finishing.
IS:2933	Enamel, exterior, a) undercoating, b) finishing.
IS:5410	Specification for cement paint, colour as required.
IS:5411	Specification for plastic emulsion paint.

14.3

Preparation of Surfaces

General

All surfaces to be painted shall be smooth, even and free from dirt or rubbish and shall be dry and protected from dampness. In general, all surfaces shall be free of any material which will adversely affect the adhesion or appearance of paint.

Plaster surface

All defective plaster shall be cut out and trimmed. All holes in internal plaster faces shall be made good with approved material. All dirt and powdery substrate shall be removed by wiping with slightly damp cloth.

Concrete surface

All laitance shall be removed by wire brush . All holes, defects shall be filled and repaired by epoxy grouts.

New metal surface

All dust and/or mill scale etc. shall be removed with a wire brush or chipping hammer or grinding if necessary. The surface of the metal work shall then be primed with an approved metal primer before application of the undercoat.

Galvanised surface

Pre-treatment of the galvanised surfaces including etch-cleaning and coating shall be carried out as per requirement. Sweep blasting or emery paper may be used to roughen the galvanised surface to get better anchor pattern.

Wood surface

All iron mongery shall be removed prior to the preparation of surfaces and shall be re-fixed upon completion of painting. All knots and resinous parts in wood surfaces shall be treated by two coats of shellac varnish. All cracks and holes shall be treated by one coat of primer and filled with approved filler.

14.4

Painting Systems

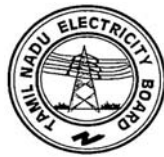
Emulsion paints

Emulsion paints shall be used for internal cement plastering and internal fair faced concrete of walls and ceilings. All emulsion paints shall be washable.

One coat of Acrylic primer sealer

Two coats of filler based on alkaline resistant polyvinyl-acetate

Two coats of polyvinyl-acetate emulsion flat finish



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Oil Bound Distemper

Oil bound distemper (IS: 428), of approved make shall be used for internal cement plastering and internal fair faced concrete of walls and ceilings. Two or coats of distemper, as found necessary shall be applied to obtain even shade.

Water proof Cement Paint

It 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.

Oil paints

Oil paints shall be used for wood surface and internal cement plastering and internal fair faced concrete in confined humid areas such as bathrooms.

One coat of Acrylic primer sealer

Two coats of filler based on alkaline resistant polyvinyl-acetate

Two finish coats based on alkyd resins

Varnishes

Varnishes shall be used for wood surfaces and shall be of one of the following types

- polyurethane varnish
- synthetic varnish of linseed oil alkyd resin

Other systems of paints

Oil resistant paints shall be epoxy paint resistant to all types of oil. Paints for steel and galvanised surfaces are specified in Section 5.14

14.5

Application Of Paints (General)

Before applying the paint, all prepared surfaces shall be dry and clean. All priming paints shall be applied by brush except for etch primer which may be applied by brush or spray. Paints shall be applied as evenly as possible to provide a smooth coating of uniform thickness. Damaged areas of priming coats or undercoats shall be made good before further coats of paints are applied. The various coats of paint shall be distinguishable from each other by their shade. The Contractor shall inform the Consultant in good time before starting to apply the next coat so that the Consultant shall have the opportunity of approving the previous coat. Painting systems shall not be carried out at temperature below 50C or above 450C. Trial coats shall be prepared at the request of the Consultant. The Contractor shall, upon completion, remove all paint where it has been spilled, splashed or spattered on surfaces including sanitary fixtures, glass and hardware. It shall be removed without marring the surface finish of the item being cleaned.



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15 **TILING AND FLOORING**

SCOPE

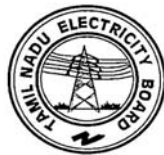
This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below:

- a) In Situ Finishes
 - i) Integral finish to concrete base
 - ii) Red Oxide of Iron finish
 - iii) Terrazzo finish
 - iv) Granolithic finish
 - v) Patent Stone
 - vi) Metallic Hardener like "Ironite" finish
 - vii) Mastic Asphalt finish
 - viii) Chemical Resistant finish
- b) Tiled Finishes
 - i) Terrazzo tile
 - ii) Chequered tile
 - iii) Glazed tile
 - iv) Tesserae (Mosaic etc.)
 - v) Chemical Resistant
 - vi) Rubber, Vinyl etc.
 - vii) Stone slab

Standards

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter.

IS:777	Specification for glazed earthenware wall tiles.
IS:2114	Code of practice for laying in situ terrazzo floor finish
IS:2571	Codes of Practice for laying in-situ concrete flooring
IS:3461	Specification for PVC Asbestos floor tiles.



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IS:3462	Specification for unbacked flexible PVC flooring.
IS:4457	Ceramic unglazed vitreous acid-resistant tiles
IS:5318	Code of practice for laying PVC flooring.
IS:5491	Code of practice for laying in-situ granolithic concrete floor topping

15.01.00 Base

The base to receive the finish is covered under other relevant specifications.

15.02.00 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Owner in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

15.03.00 Installation

15.03.01 *Special Materials*

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Owner. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

15.03.02 *Workmanship*

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Owner's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Owner so desires the Contractor shall get the finishing items installed by the manufacturer.

15.03.03 *Preparation of the Base Surface*

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Owner and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and



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cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Owner shall be taken as per the acceptability of the surface.

15.04.00 In Situ Finishes

15.04.01 *Integral Finish to Concrete Base*

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still green a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per sq.m. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying.

As desired by the Owner the surface, while still 'green' shall be indented by pressing strings. The marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

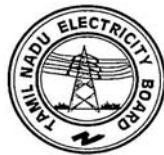
15.04.02 *Red Oxide of iron finish*

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm or as per schedule of item for horizontal and 20 mm or as per schedule of item for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.



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b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) Topping

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

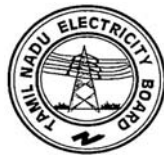
c) Laying

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 kg. of the mixture shall be consumed/per sq.m. for horizontal surface, and 1.0 kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Owner, is achieved. The finish shall be washed and cleaned just before handing over.



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15.04.03 *Terrazo Finish : In Situ*

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm for horizontal and 20 mm or as per schedule of items for vertical surface of which the topping shall be not less than 10 mm or as per schedule of items. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1½ Parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Owner. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.



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c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

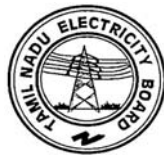
d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polishing

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no. 60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no. 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no. 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no. 60), second rubbing with medium grade (no. 80) and final rubbing and polishing with fine grade (no. 120).

The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Owner. The final polishing shall be postponed till before handing over if desired by the Owner. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. sq.m. water



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sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

15.04.04 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement : 1 part coarse sand : 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

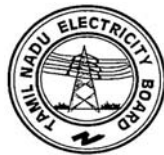
Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Owner, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base.

The base concrete shall be prepared as stated in clause 15.04.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.



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e) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 15.04.03 (e) shall be followed. However, the ultimate polish required shall be decided upon by the Owner.

g) Finishing

Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified in the Schedule of Items. The concentration and method of application of the solutions shall be as specified in IS:5491.

15.04.05 *Patent Stone*

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 15.04.03(a) except that the topping shall be 6 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 15.04.03 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) Laying

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be as in contact with another already laid till the contraction of the latter has already taken place.



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The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall trowelled to a dense finish to the satisfaction of the Owner. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Owner.

15.04.06 *Metallic Hardener Like "Ironite" Finish*

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

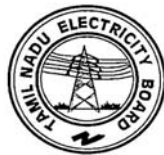
The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the Owner, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.



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The finish shall be laid while the concrete underbed is still very “green” within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

15.04.07 *Mastic Asphalt Finish*

This is a one layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing or schedule of items.

b) Materials

Bitumen shall be industrial bitumen of the grades 90/20 and 75/20 conforming to IS:702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick and 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform to IS:1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205° C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.



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The mastic shall be laid in suitable panels of about 20 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

15.04.08 *Chemical Resistant in Situ Finish*

Chemical resistant in situ finish shall be an epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Owner shall have to be fully satisfied by test results and examination of similar treatment already in existence. The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

15.05.0 Tiled Finish

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

15.05.01 *Terrazzo Tile Finish*

The finish will consist of manufacture terrazzo tile and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

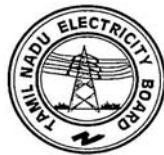
The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles : Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.Cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.



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The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 15.04.03 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix : Underbed

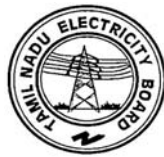
The underbed for floor and similar horizontal surfaces shall be 1 part lime putty : 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Owner taken.



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At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 15.04.02 (c) may be used for dividing the work into suitable panels.

c) Grinding and Polishing

Procedure shall be same as Clause 15.04.03(e) . Grinding shall not commence earlier than 14 days after laying of tiles.

15.05.02 *Chequered Tile Finish*

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 15.04.03(a)

b) Tiles : Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 15.05.01 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) Underbed

As per clause 15.04.03 (c).

d) Laying

As per clause 15.04.03 (d)

e) Grinding and Polishing

As per clause 15.04.03 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.



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15.05.03 *Glazed Tiles Finish*

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20 mm and 25 mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles : Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 200 mm x 200 mm nominal sizes and 10 mm thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Owner. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix : Underbed

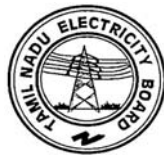
The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

d) Laying

Same as clause 15.04.02 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.



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15.05.04 Tesseræ Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm and 25 mm.

b) Tesseræ Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix : Underbed

Same as clause 15.04.03(b)

d) Laying

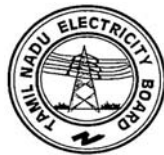
The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Owner. Otherwise clause 20.04.03(d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

15.05.05 Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant



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to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 15.04.03.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Owner.

15.05.06 *Rubber, Vinyl or Vinyl Asbestos Tiles Finish*

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.



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Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix : Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement : 4 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

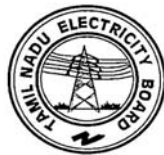
e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

15.05.07 *Stone Slab Finish : Marble, Stone and Similar Fine Grained Stone*

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs may be 25 mm, 30 mm or 40 mm thick as specified.



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b) Stone Slab

The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix : Underbed

Same as clause 20.04.03 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, a thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiseling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 20.04.03 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

15.05.08 *Stone Slab Finish : Sand Stone and Similar Coarse Grained Stone Finish*

Generally clause 15.04.03 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.



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The slabs shall be rough chiseled or fine chiseled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiseling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

15.06.00 Acceptance Criteria

The finish shall be checked specially for :

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

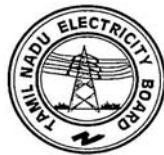
16 FALSE CEILING

SCOPE

The work under this Section shall include the supply and insulation of false ceiling using insulation / acoustic boards, plaster of paris boards. Perspex etc. together with the suspension system as shown on drawing or specified in Schedule 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 instructed by the Owner.

16.01.00 Installation

16.02.00 Suspension System



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16.02.01 *General*

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.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer. All wood supports shall be painted with two coats of "Solignum" or other approved wood preservative before erection.

16.02.02 *Metal Grid Suspension System*

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beardshell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively locked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

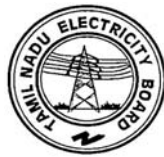
16.02.03 *Timber Grid Suspension System*

Unless otherwise shown on drawings, the suspension system shall consist of 50 mm x 50 mm pretreated teakwood batten grid false in the same manner described for metal grid system. The spacing of timber battens shall be as shown on drawing. Extra battens shall be provided where necessary for openings for light fixtures A C grills etc.

16.03.00 *Ceiling Panels*

16.03.01 *Materials*

Ceiling panels shall be best quality material in thickness and properties call for in the "Schedule of Items". The Contractor shall submit test certificates to the



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Owner for approval before bulk supply. The ceiling panels may be of the following types:

- a) Plaster of Paris boards
- b) Expanded polystyrene insulation boards
- c) Fibre insulation boards
- d) Wood particle boards
- e) Glass fibre reinforced polystyrene sheets
- f) Flat asbestos sheets

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvres etc. shall be from approved manufacturers and in thickness specified in schedule.

16.03.02 *Installation of Ceiling Panels*

Installation of ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Owner.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and schedule of items, 6 mm thick cement: lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

16.04.00 *Acceptance Criteria*

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. Shall be of exact dimensions and in exact locations.



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16.05.00 Rates

Shall be unit rates for complete items called for in the "Schedule of Items". No extra payment will be made for arrangement for lighting fixtures air conditioning diffusers access panels, etc. The rate shall include all cutting and wastage from standard size sheets boards, runners, etc.

16.07.00 I. S. Codes

IS:2441 - Code of Practice for fixing ceiling coverings.

17.00.00 **FALSE FLOORING**

SCOPE

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

17.01.00 False Flooring System

17.01.01 *Base*

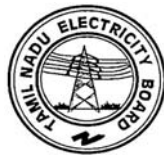
The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

17.01.02 *Supporting Structure*

The supporting structure shall comprise of fabricated jacks made out of 25 mm. dia. MS rounds having 150 mm. threads at top. This jack shall be welded to 100 mm x 100 mm x 6 mm thick MS base plate pedestal. Pedestals shall be vertically true and located at 600 mm. centre to centre to conform to the size of the floor panels and shall be fixed to the RCC floor slab with ARALDITE. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The capital shall be of aluminium alloy die cast and shall receive cold rolled MS floor supporting channels of size 40 mm x 40 mm x 3.15 mm thickness as per drawings, both for main and cross runners. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

17.01.03 *Floor Panel*

The floor panels shall be made of phenol formaldehyde bonded particle board treated with fire resistant paint as per schedule items. Size of each panel shall be 600 mm. x 600 mm. with all panel edges finished to a tolerance of ± 0.25 mm. on the diagonals. The edges of the floor panels shall be covered by 4



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mm. thick rigid PVC edging. The underside of the panel shall have 0.05 mm. thick Aluminium foil which shall be fixed to the particle board with resin based adhesive.

17.01.04 *Strength*

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

17.01.05 *Surface Finish*

All removable panels shall have the top surface finished with 2 mm thick Antistatic Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

17.01.06 *Skirting*

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

17.01.07 *Installation*

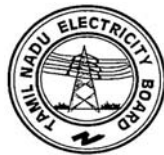
All steel surfaces are to be protected by pointing over a primer as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Owner-in-Charge shall be protected by the Contractor with Kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

17.02.00 *Acceptance Criteria*

The false flooring system shall be checked specially for:

- a) Level
- b) Alignment of joints
- c) Thickness of joints
- d) Surface finish
- e) Colour and texture



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18 SHEET WORK IN ROOF AND SIDING

SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc., as shown on drawings and schedule of items.

IS Codes

The following are some of the important IS Codes relevant to this sections :

IS : 3007 : Code of practice for laying of asbestos cement sheets

IS : 2527 : Code of practice for fixing rain water gutters and down pipes for roof drainage

IS : 1626 : Specification for asbestos cement building pipes gutters and fittings

IS : 277 : Specification for galvanised steel sheets (plain and corrugated)

18.01.00 Installation

18.02.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

18.03.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Owner fixing of gutters and down pipes shall be according to IS:2527.



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18.03.01 *Asbestos Sheetting*

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge cappings, corner pieces, ventilators, north light curves etc.

18.03.02 *C.G.I. Sheetting and Aluminium Sheetting*

Side laps shall be 2 corrugations for roof and one corrugation for side sheetting. End laps shall be minimum 150 mm for roof and 100 mm for side sheetting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground the sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washets. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. The length of the hook or J-bolts shall be to suit the sections of the bearers.

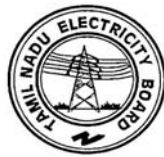
Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.

18.03.03 *Fibre Glass Reinforced Plastic Sheetting*

This shall be of thickness and profile as mentioned in the Schedule of Item. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheetting the end and side laps and fixing device shall be same as used for general sheetting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in schedule of items. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure as mentioned in Schedule.

18.03.04 *Precoated metal sheetting for roof shall be of precoated cold rolled sheet of total coated thickness (TCT) 0.58 to 0.68 mm of approved manufacturer. The sheet shall be metallic hot deep coated with an alloy of 55% aluminium, 43% zinc and 1.55 silicon coating mass shall be 150 gms/sq.m. sheet shall be fixed with fastening clip and self tapping fastener. Ridge for slope roof shall be of similar material and shall be fixed with necessary self tapping screws as per manufacturer details.*

Thermally insulated sandwiched metal cladding for external facade shall be of approved manufacturer. Sheetting shall Hi Rib 0.5 mm troughed sheetting manufactured from aluminium alloy high tensile steel (550Mpa) coated with fluoro polymer (PV F2 or equivalent) and shall have life span sustenance against aggressive weathering action. Inner profiled sheet shall be with profile sheet of .6 mm thick (total coated thickness) permanently coated galvanised sheet.



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Galvanised coating shall be not less than 120 gm/sq.m. and sandwiched insulation of 25 mm thick or as per design requirement shall be bonded mineral wool blanket or equivalent conforming to IS: 8183 (minimum density of 32/kg/cum for glass wool and 48/kg/cum for rock wool) having minimum coefficient of thermal conductivity of 0.49 mW/cm deg C (at 50 degree) Cladding shall be fixed to supports/rails by nuts, bolts, hooks, washers self tapping screws of stainless steel Austentic grade) conforming to IS:1367 (part 14) including sealents, gaskets, PVC tape 0.25 mm thick, flashing, black synthetic rubber external trough filler and 25X3 mm aluminium earthing.

18.04.00 Acceptance Criteria

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

- a) Side and end laps
- b) Absence of cracks, holes or damages in sheet
- c) Spacing of bolts
- d) Provision of double washers (G.I. and asbestos or bituminous washers)
- e) Proper installation of flashing

19 **DRAINAGE AND SEWERAGE**

19.1 General

The work to be carried out under this chapter comprises various kinds of drainage culverts, pipes, and the like, including all accessories as well as pipes and accessories for sewerage.

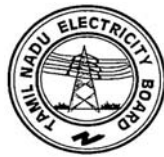
The Contractor shall design and prepare a flow diagram of the drainage system to be executed. The diagram shall show material and dimensions of the pipes to be used and the proportion of slope, as well as the invert level at all connection points. The flow diagram is subject to approval of the Consultant.

The pipes and structures of the drainage system shall be placed with sufficient safety against buoyancy. All earthworks in connection with the work specified hereunder shall be carried out as described under chapter-"Earth work"

All concrete work in connection with the work specified hereunder shall be carried out as described under chapter- "Plain and Reinforced Concrete".

19.2 Standards

Unless otherwise specified herein, the following standards shall apply to the works covered by this chapter:



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IS:404	Lead pipes (All parts)
IS:405	Lead sheet and strip (All parts)
IS:458	Precast concrete pipes (with and without reinforcements)
IS:651	Salt glazed stoneware pipes and fittings
IS:782	Caulking lead
IS:783	Code of practice for laying of concrete pipes
IS:1172	Code of basic requirement for water supply, drainage and sanitation
IS:1230	Cast iron rain water pipes and fittings
IS:1239	Mild steel tubes and tubulars and other wrought steel fittings (All parts)
IS:1536	Centrifugally cast(spun) iron pressure pipes for water, gas and sewage
IS:1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS:1626	Asbestos cement building pipes, gutters and fittings (spigot and socket type).
IS:1726	Cast iron manhole covers and frames
IS:1729	Sand cast iron spigot and socket soil waste and ventilating pipes, fittings and accessories.
IS:1742	Code of practice for building drainage
IS:2470	Code of practice for installation of septic tanks (All parts)
IS:2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage
IS:3006	Specification for chemically resistant glazed stoneware pipes and fittings
IS:3114	Code of practice for laying of cast iron pipes
IS:3486	Cast iron spigot and socket drain pipes
IS:3597	Methods of test for concrete pipes
IS:4127	Code of practice for laying of glazed stoneware pipes

19.3

Material

Material and structural parts shall be standardised and shall be adequate for the purpose required. All material shall comply with local regulations (if any) regarding quality and dimensions subject to the approval of the Consultant.

Piping and fittings shall comply with the following standards:

Unplasticized PVC pipes for gravity sewers and for underground drainage shall comply with IS:4985.

Cast iron pipes and ductile iron pipes shall comply with relevant Indian Standards as mentioned above.

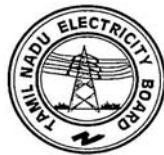
Stoneware pipes shall conform to IS:651.

RCC pipes for underground sewer and culverts shall be of class NP2 or NP3 conforming to IS:458.

Cast Iron rain water pipes shall conform to IS:1230.

Glass reinforced plastics (GRP) shall comply with IS:12709.

Manhole covers and frames shall comply with IS:1726.



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All pipes shall be marked immediately after manufacture and the marking shall include:

- name of manufacturer
- date of manufacturing and serial number
- nominal diameter and pipe class

Pipe Trenches

Prior to laying of pipes, the respective pipe trenches shall be subject to thorough inspection by the Consultant with respect to alignment, slope, dimensions and suitability of bottom to meet requirements of proper pipe laying.

In general, each pipe trench deeper than 1.5 m shall be secured by means of planks, sheet piling, struts and bracings, whatever is required according to the soil conditions, groundwater, nearby road vibration resulting from traffic. The spacing of bracings shall be such as to allow mechanical excavation of the trench where required. All pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported.

The width of a trench shall be adequate for satisfactory jointing of pipes and thorough tamping of the bedding material under and around the pipes. The bedding surface shall provide a firm but slightly yielding foundation of uniform density throughout the entire length of the pipe or the culvert and shall in general be slightly cambered in a direction parallel to the pipe centreline to compensate for expected settlement and ensure tight joint in the lower half of the pipe.

Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template. Where rock in either edge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness of 200 mm minimum. Where a firm foundation is not encountered at the grade established, due to soft or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected material as approved by the Consultant, properly compacted to provide adequate support for the pipes.

Deviations from given levels shall not be greater than ± 20 mm.

19.4

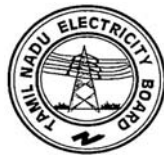
Transport, Placing And Support Of Pipes

Special care shall be taken to avoid any damage during transport, loading and off-loading, storage, etc.

The excavated material shall be thrown on one side of trench and the pipes stacked on the other side. Storing of pipes alongside trenches shall be done only for the shortest time possible before placing in the trench. All pipes shall be checked for defects and damages prior to placing.

Material that does not conform to the specification or which is found to be defective or damaged shall be rejected and removed from the site. If more than 10 % of the pipes are rejected because they do not conform to the specification, the Consultant retains the right to reject the whole consignment.

During connection of pipe sections, the contact surfaces carrying sealing compounds shall be kept clean. All open ends for later connections shall be closed to avoid entering of soil or other contamination into the bores. The pipes shall be laid with their socket ends facing the direction of the flow (such that flow is from socket end to spigot end). The pipes shall be lowered in the trenches by a method as approved by the Consultant. The pipes shall then be joined by



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caulking. After placing, each pipe section shall be thoroughly checked as to alignment, level and slope.

After each section of the pipeline has been laid it shall be tested for water tightness before backfilling the trench. On successful completion of testing, the trench shall be backfilled with the excavated earth in layers of 200 mm and shall be watered and rammed. Any subsidence occurring in the line of trenches after backfilling shall be repaired by the Contractor

Pipe supports shall be so constructed as to guarantee the uniform transmission of loads. For concrete supports, a cement-mortar layer shall be applied before placing the pipes to guarantee a uniform transmission of forces.

Dimensions

Nominal diameters shall refer to internal diameters of pipes. The nominal length of a pipe shall be the effective length of the installed pipe.

19.5

Structures of Drainage System

Inspection and Diversion Pits / Manholes

Reinforced concrete or rubble masonry (in 1:4 cement mortar) pits / manholes shall be placed at every change of dimension, direction and/or slope; furthermore, on straight lines at a maximum distance of 50 m, or as shown on the approved working drawings. The grade of concrete for manholes shall be M20 for cast in-situ. Manholes may be prefabricated or cast in place. Sections of connecting pipes shall be incorporated into the construction of manholes and placed at the elevation, direction, and grade required. The inner ends of the pipes shall be flush with the inner faces of the walls, unless otherwise specified. Half round channels of size suitable for the inlet and outlet pipe diameters shall be formed on the floor of the pit with PCC 1:3:6. The floor of the pit shall be haunched towards the channel as per requirement. Inside of pits shall be finished with cement-sand plaster (1:4) and finished smooth with cement punning. Care shall be taken to avoid unevenness on the surface and sharp bends in the channel. The invert level after finishing shall be as shown in the drawings.

Gully trap pits

Gully trap pits shall be constructed as indicated in the drawings. The construction and finishing of the pit shall be as described above for inspection pits. The cast iron grating shall be set flush with the finished ground / floor level.

Oil Separator

Oil polluted sanitary drainage shall be led through mud traps and oil separators installed immediately outside the buildings before entering the sanitary drainage system. The oil separator tank shall be made from reinforced concrete.

Septic Tanks

For the treatment of sanitary sewage, a septic tank having a minimum of 3 chambers shall be constructed. Septic tank shall consist of the RCC/masonry tank with inlet and outlets therefrom, complete with all necessary earthwork and backfilling. The details of septic tank shall be as per IS:2470. The chambers shall be separated by walls with slits. Each chamber shall have one manhole cover for cleaning with mobile pump. Before the outlet in the last chambers, a screen



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board shall be provided to prevent the passage of floating matter into the discharge pipe.

Septic tank shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wire meshes and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

After the Septic Tank has been tested to be watertight and the sewage system is checked, the tank shall be filled with water to its outlet before the sewage is let into the tank. It shall be seeded with well-digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge, small quantity of decaying organic matter such as digested cow dung may be introduced.

The volume of the septic tank shall be adequate for the sanitary sewage owing to the number of persons occupying the building, subject to the Consultant approval.

The effluent from the septic tank shall be disposed by any of the following methods depending on the project requirements:

- Connecting to a treatment plant.
- Connecting to soak pit for absorption by soil.
- Allowing to be absorbed by soil through open jointed stoneware pipes laid in a trench filled with broken bricks.

Soak Pit

A soak pit shall be arranged at the location shown on drawings for the disposal of sanitary sewage from the outlet of the septic tank. The soak pit shall be constructed in-situ.

It shall consist of a minimum 900 mm dia pit 1.0m in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6). The lower part shall be perforated and filled with brickbats. Inspection opening of 700 mm x 700 mm shall be provided. The cover of the inspection opening shall be of cast-iron. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti mosquito measure.

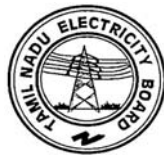
19.6 Concrete Encasement Of Pipes

Pipelines running under roads, etc. shall be encased in concrete of Grade M20 for full length. Before concrete is placed, the pipe and all fittings shall receive a double wrapping of bituminous felt. The thickness of the concrete encasement around the pipeline shall be at least the same as the pipe diameter. The concrete shall be reinforced by reinforcing steel bars in case of lack of space in any direction, side or top.

19.7 Accessories

Cast Iron Covers and Frames

Cast-iron covers and frames shall be of sound manufacture and free from projections or voids, treated with two heavy coats of an approved paint.



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Thereafter, the covers shall be fixed on to the previously installed frames after lining from the inside with grease and sand mix.

Frames shall be square and covers shall be of the circular type according to the dimensions indicated on the drawings.

Covers and frames shall be fixed in such a way as to match adjacent surface levels with tolerances not exceeding ± 3 mm.

Rising and Lifting Bars

One rising and lifting bar of approved design shall be supplied by the Contractor with each ten (10) manhole covers and frames.

Grates and Frames for Gullies

Grates and frames for horizontal gullies shall be made of cast-iron and according to the dimensions shown on the drawings. They shall be treated on both sides with two coats of approved rustproof paint.

Step Irons

Step irons shall be either galvanised steel or corrosion protected cast-iron. Steps should be a minimum of 300 mm long and 150 mm away from the wall.

19.8

Testing

General

The Contractor shall test all drainage and sewerage pipelines, joints and fittings before back filling the trenches. The tests shall be carried out between each two manholes in the presence of the Consultant.

The following points shall be considered when conducting the tests:

pipelines shall be clean and dry and the joints shall not be covered with soil

the underground water level shall be at the lowest possible level

testing shall be carried out by water subject to the Consultant's approval.

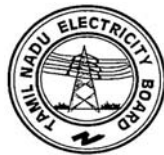
Testing by Water

Water shall be so filled in all parts of pipes, of whatever diameter to be tested, that all air in the pipes is expelled and the pipes are completely filled with water. The pipes shall be tested for 0.5 bar pressure of water and the time for test shall be 12 hours.

If any leak is noticed in the pipeline, the Contractor shall repair such leak to the satisfaction of the Consultant.

If in the opinion of the Consultant any damage had occurred in the pipelines in the process of pouring the concrete or backfilling, he shall have the right to order re-testing of the doubtful part. If a second testing proves that the pipeline is not serviceable, then the Contractor shall have to locate the damage, make it good and carry out re-testing until he secures satisfactory results.

The Contractor shall fix plugs in ends of pipes to be tested and shall take necessary precautions to prevent plugs or fixing tools from getting inside the pipes as a result of water flushing.



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20 CONCRETE ROADS AND PAVEMENT

20.01.0 SCOPE

This specification covers all work required for the construction of rigid pavement including box cutting, edging, sub grade, dry lean concrete sub base, cement concrete pavement, wearing course etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

20.01.01 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

- a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.
- b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.
- c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

20.01.02 Work to be provided for by others

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

20.01.03 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

- 1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.
- 2. IRC-58 Guidelines for the design of plain jointed rigid pavements for highways.
- 3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.
- 4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.
- 5. IS:2212 Code of Practice for Brickwork.
- 6. IS:783 Code of Practice for Laying of Concrete Pipes.



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7.IRC:SP-49 Guidelines for the use of dry lean concrete as the sub base for rigid pavements.

8.Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard specification, any other standard practice as may be specified by the Engineer shall be followed.

Conformity with Designs

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

20.01.04 Materials to be Used

General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

Quality Control

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for roadworks are described hereinafter.

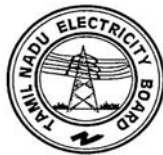
i) Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 40 mm.

ii) Longitudinal Profile

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

Sub-grade $\pm$	25 mm
Sub-base $\pm$	20 mm
Base course $\pm$	15 mm
Wearing course $\pm$	10 mm



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

iii) Surface Regularity of Subgrade and Pavement Courses

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

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

NOTES :

1. **For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

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

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

20.01.05 EXECUTION

i) Shoulder Construction

a) Description

This work shall consist of constructing shoulders on either side of the pavement, in accordance with the requirements of this specification and in conformity with the lines, grades and cross- sections shown on the drawings or as directed by the Engineer.

b) Materials

Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub- base construction respectively.

c) Construction Operations

Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.



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In the case of bituminous courses, shouldering operations shall start only after the pavement course has been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction, the required cross- fall shall be maintained to drain off surface water.

ii) Kerb

a) Material

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-15. The blocks shall be 100 mm wide and of suitable length. The depth of blocks unless otherwise mentioned elsewhere, shall be 375 mm considering 225 mm height of footpath from the road level.

b) Laying

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

20.02.00 SUB-BASE (DRY LEAN CONCRETE SUB BASE)

Description

This work shall consist of construction of dry lean concrete sub base for cement concrete pavement on a prepared sub grade in accordance with the requirements of this specification. The work shall conform to lines grades and cross section shown on drawing and as directed by Engineer.

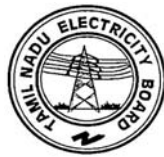
a) Materials

The materials to be used shall be as follows.

b) Cement

Following type of cement shall be used with prior approval of Engineer.

Ordinary Portland cement, Portland slag cement, Portland Puzzolona cement conforming to IS:269, IS:455, IS:1489 respectively.



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c) Aggregates

All aggregates for lean concrete shall be of natural material complying with IS:383. The aggregate shall not be alkali deactive. The limits of deleterious material shall not exceed the requirements in IS:383. all aggregates shall be free from dirt, washed and drained for at least 72 hrs before batching.

d) Coarse aggregates

Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of the coarse aggregate shall be 25 mm.

e) Fine aggregate

The fine aggregate shall consist of clean, natural sand or crushed stone sand or a combination of the two and shall conform to IS : 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica, organic and other foreign matter.

The coarse and fine aggregates may be obtained in either of the following manner:

- (i) In separate nominal sizes of coarse and fine aggregates and mixed together intimately before use.
- (ii) Separately as 25 mm nominal single size, 12.5 mm nominal size graded aggregates and fine aggregate of crushed stone dust or sand or a combination of these two.

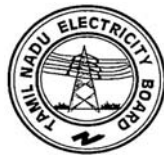
The material after blending shall conform to the grading as indicated in Table.

AGGREGATE GRADATION FOR DRY LEAN CONCRETE

Sieve designation	Percentage passing the sieve by weight
26.50 mm	100
19.00 mm	80-100
9.50 mm	55-75
4.75 mm	35-60
600.00 micron	10-35
75.00 micron	0-8

f) Water

Water used for mixing and curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS : 456.



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g) Storage of materials

All materials shall be stored in accordance with the provisions indicated elsewhere in the document.

20.02.01 Proportioning of Materials for the Mix

a) The mix shall be proportioned with a maximum aggregate cement ratio of 15:1. The water content shall be adjusted to the optimum so as to ensure full compaction under rolling which shall be accessed at the time of rolling. The strength and density requirements of concrete shall be determined by making trial mixes.

b) Moisture content

The right amount of water for the lean concrete in the main work shall be decided so as to ensure full compaction under rolling and shall be assessed at the time of rolling the trial length. Too much water will cause the lean concrete to be heaving up before the wheels and picked up on the wheels of the roller and too little will lead to inadequate compaction, a low in-situ strength and an open-textured surface.

The optimum water content shall be determined and demonstrated by rolling during trial length construction and the optimum moisture content and degree of compaction shall be got approved from the Engineer. While laying in the main work, the lean concrete shall have moisture content between the optimum and optimum +2 per cent, keeping in view the effectiveness of compaction achieved and to compensate for evaporation losses.

c) Cement content

The minimum cement content in the lean concrete shall not be less than 150 kg/cu.m. of concrete. If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary without additional cost compensation to the Contractor.

d) Concrete strength

The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 903.5.1.1.(As per MOST standards) shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

20.02.02 Subgrade

The subgrade shall conform to the grades and cross sections shown on the drawings and shall be uniformly compacted to the design strength in accordance with these Specifications and Specification stipulated in the Contract. The lean concrete subbase shall not be laid on a subgrade softened



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by rain after its final preparation; surface trenches and soft spots, if any, must be properly back-filled and compacted to avoid any weak or soft spot. As far as possible, the construction traffic shall be avoided on the prepared subgrade. A day before placing of the sub-base, the subgrade surface shall be given a fine spray of water and rolled with one or two passes of a smooth wheeled roller after a lapse of 2-3 hours in order to stabilise loose surface. If Engineer feels it necessary, another fine spray of water may be applied just before placing sub-base.

20.02.03 Construction

a) General

The pace and programme of the lean concrete sub base construction shall be matching suitably with the programme of construction of the cement concrete pavement over it. The sub-base shall be overlaid with cement concrete pavement only after 7 days after sub-base construction.

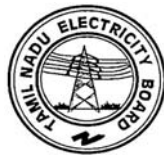
b) Batching and mixing

The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clause 602.9.3.2 of MOST standards. The cement from the bulk stock shall be weighed separately from the aggregates. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity for the laying arrangements. The batching and mixing shall be carried out preferably in a forced action central batching and mixing plant having necessary automatic controls to ensure accurate proportioning and mixing. Other types of mixers shall be permitted subject to demonstration of their satisfactory performance during the trial length. The type and capacity of the plant shall be got approved by the Engineer before commencement of the trial length. The weighing balances shall be calibrated by weighing the aggregates, cement, water and admixtures physically either by weighing in the large weighing machine or in a weigh bridge. The accuracy of weighing scales of the batching plant shall be within ± 2 per cent in the case of aggregates and ± 1 per cent in the case of cement and water.

The design features of Batching Plant should be such that the shifting operations of the plant will not take very long time when they are to be shifted from place to place with the progress of the work.

c) Transporting

Plant mix lean concrete shall be discharged immediately from the mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tippers/dumpers with tarpaulin during transit. The concrete shall be transported by tipping trucks, sufficient in number to ensure a continuous supply of material to feed the laying equipment to work at a uniform speed and in an uninterrupted manner. The lead of the batching plant to paving



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site shall be such that the travel time available from mixing to paving as specified in Clause 601.5.5.2 of MOST standards will be adhered to.

d) Placing

Lean concrete shall be laid/placed by a paver with electronic sensor. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. The paving machine shall have high amplitude tamping bars to give good initial compaction to the sub-base.

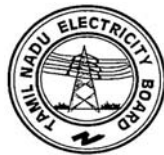
The laying of the two-lane road subbase done either in full width or lane by lane. Preferably the lean concrete shall be placed and compacted across the full width of the road, by constructing it in one go or in two lanes running forward simultaneously. Transverse and longitudinal construction joints shall be staggered by 500-1000 mm and 200-400 mm respectively from the corresponding joints in the overlaying concrete slabs.

e) Compaction

The compaction shall be carried out immediately after the material is laid and levelled. In order to ensure thorough compaction which is essential, rolling shall be continued on the full width till there is no further visible movement under the roller and the surface is closed. The minimum dry density obtained shall be 97 per cent of that achieved during the trial length construction vide Clause 601.7 of MOST standards. The densities achieved at the edges i.e 0.5 m from the edge shall not be less than 95 percent of that achieved during the trial construction vide Clause 601.7 of MOST standards.

The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possibly and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the layer and the final finishing of the same shall not exceed 90 minutes when the concrete temperature is above 25 and below 30 degree Celsius and 120 minutes if less than 25 degree Celsius. This period may be reviewed by the Engineer in the light of the results of the trial run but in no case shall it exceed 2 hours. Work shall not proceed when the temperature of the concrete exceeds 30 degree Celsius. If necessary, chilled water or addition of ice may be resorted to for bringing down the temperature. It is desirable to stop concreting when the ambient temperature is above 35°C. After compaction has been completed, roller shall not stand on the compacted surface for the duration of the curing period except during commencement of next day's work near the location where work was terminated the previous day.

Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 kN static weight are considered to be suitable for rolling dry lean concrete. In case any other roller is proposed, the same shall be got approved from the Engineer, after demonstrating its performance. The number of passes required to obtain maximum compaction depends on the thickness of the lean concrete, the compatibility of the mix, and the weight and type of the roller etc., and the same



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as well as the total requirement of rollers for the job shall be determined during trial run by measuring the in-situ density and the scale of the work to be undertaken.

In addition to the number of passes required for compaction there shall be a preliminary pass without vibration to bed the lean concrete down and again a final pass without vibration to remove roller marks and to smoothen the surface.

Special care and attention shall be exercised during compaction near joints, kerbs, channels, side forms and around gullies and manholes. In case adequate compaction is not achieved by the roller at these points, use of plate vibrator shall be made, if so directed by the Engineer.

The final lean concrete surface on completion of compaction and immediately before overlaying, shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects. The final surface shall be inspected immediately on completion and all loose, segregated or defective areas shall be corrected by using fresh lean concrete material laid and compacted as per Specification. For repairing honeycombed surface, concrete with aggregates of size 10 mm and below shall be spread and compacted. It is necessary to check the level of the rolled surface for compliance. Any level/thickness deficiency should be corrected after applying concrete with aggregates of size 10 mm and below after roughening the surface. Similarly the surface regularity also should be checked with 3 m straight edge. The deficiency should be made up with concrete with aggregates of size 10 mm and below.

Segregation of concrete in the dumpers shall be controlled by premixing each fraction of the aggregates before loading in the bin of the batching plant, by moving the dumper back and forth while discharging the mix on it and other means. Even paving operation shall be such that the mix does not segregate.

f) Joints

Contraction and longitudinal joints shall be provided as per the drawing.

At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical face where the correct thickness of the properly compacted material has been obtained.

g) Curing

As soon as the lean concrete surface is compacted, curing shall commence. One of the following two methods shall be adopted:

(a) The initial curing shall be done by spraying with liquid curing compound. The curing compound shall be white pigmented or transparent type with water retention index of 90 per cent when tested in accordance with BS 7542. Curing compound shall be sprayed immediately after rolling is complete. As soon as



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the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days.

(b) Curing shall be done by covering the surface by gunny bags/hessian, which shall be kept continuously moist for 7 days by sprinkling water.

20.02.04 Trial Mixes

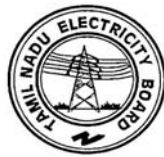
The Contractor shall make trial mixes of dry lean concrete with moisture contents like 5.0, 5.5, 6.0, 6.5 and 7.0 per cent using cement content specified and the specified aggregate grading but without violating the requirement of aggregate-cement ratio specified in Clause 601.3.1 of MOST standards. Optimum moisture and density shall be established by preparing cubes with varying moisture contents. Compaction of the mix shall be done in three layers with vibratory hammer fitted with a square or rectangular foot as described in Clause 903.5.1.1 of MOST standards. After establishing the optimum moisture, a set of six cubes shall be cast at that moisture for the determination of compressive strength on the 3rd and the seventh day. Trial mixes shall be repeated if the strength is not satisfactory either by increasing cement content or using higher grade of cement. After the mix design is approved, the Contractor shall construct a trial section in accordance with Clause 601.7 of MOST standards.

If during the construction of the trial length, the optimum moisture content determined as above is found to be unsatisfactory, the Contractor may make suitable changes in the moisture content to achieve a satisfactory mix. The cube specimens prepared with the changed moisture content should satisfy the strength requirement. Before production of the mix, natural moisture content of the aggregate should be determined on a day-to-day basis so that the moisture content could be adjusted. The mix finally designed should neither stick to the rollers nor become too dry resulting in raveling of surface.

20.02.05 Trial Length

The trial length shall be constructed at least 14 days in advance of the proposed date of commencement of work. At least 30 days prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a "Method Statement" giving detailed description of the proposed materials, plant, equipment, mix proportion, and procedure for batching, mixing, laying, compaction and other construction procedures. The Engineer shall also approve the location and length of trial construction which shall be a minimum of 60 m length and for full width of the pavement. The trial length shall contain the construction of at least one transverse construction joint involving hardened concrete and freshly laid sub-base. The construction of trial length will be repeated till the Contractor proves his ability to satisfactorily construct the subbase.

In order to determine and demonstrate the optimum moisture content which results in the maximum dry density of the mix compacted by the rolling equipment and the minimum cement content that is necessary to achieve the



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strength stipulated in the drawing, trial mixes shall be prepared as per Clause 601.6 of MOST standards.

After the construction of the trial length, the in-situ density of the freshly laid material shall be determined by sand replacement method with 20 cm dia density cone. Three density holes shall be made at locations equally spaced along a diagonal that bisects the trial length; average of these densities shall be determined. These main density holes shall not be made in the strip 50 cm from the edges. The average density obtained from the three samples collected shall be the reference density and is considered as 100 per cent. The field density of regular work will be compared with this reference density in accordance with Clauses 601.5.5.1 and 903.5.1.2 of MOST standards. A few cores may be cut as per the instructions of the Engineer to check segregation or any other deficiency.

The hardened concrete shall be cut over 3 m width and reversed to inspect the bottom surface for any segregation-taking place. The trial length shall be constructed after making necessary changes in the gradation of the mix to eliminate segregation of the mix. The lower surface shall not have honey-combing and the aggregates shall not be held loosely at the edges.

The trial length shall be outside the main works. The main work shall not start until the trial length has been approved by the Engineer. After approval has been given the materials, mix proportions, moisture content, mixing, laying, compaction plant and construction procedures shall not be changed without the approval of the Engineer.

20.02.06 Tolerances for Surface Regularity, Level, Thickness, Density and Strength

The tolerances for surface regularity, level, thickness, density and strength shall conform to the requirements given in Clause 903.5 of MOST standards. Control of quality of materials and works shall be exercised by the Engineer in accordance with section 900 of MOST standards.

20.02.07 Traffic

No heavy commercial vehicles like trucks and buses shall be permitted on the lean concrete sub-base after its construction. Light vehicles if unavoidable may, however, be allowed after 7 days of its construction with prior approval of the Engineer.



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20.03.00 BASE COURSE - CEMENT CONCRETE PAVEMENT

20.03.01 Materials

a) Source of materials

The Contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work. If the Contractor later proposes to obtain materials from a different source, he shall notify the Engineer for his approval, at least 45 days before such materials are to be used with relevant test data.

b) Cement

Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer, but the preference should be to use at least the 43 Grade or higher.

i) Ordinary Portland Cement, 33 Grade IS : 269.

ii) Ordinary Portland Cement, 43 Grade IS : 8112.

iii) Ordinary Portland Cement, 53 Grade IS : 12269.

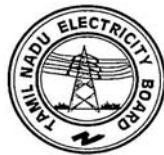
If the soil around has soluble salts like sulphate in excess of 0.5 per cent, the cement used shall be sulphate resistant and shall conform to IS : 12330.

c) Admixtures

Admixtures conforming to IS : 6925 and IS : 9103 shall be permitted to improve workability of the concrete or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious effect on steel bars. The particulars of the admixture and the quantity to be used, must be furnished to the Engineer in advance to obtain his approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in trial paving works. If air entraining admixture is used, the total quantity of air in air-entrained concrete as a percentage of the volume of the mix shall be 5 ± 1.5 per cent for 25 mm nominal size aggregate.

d) Aggregates

Aggregates for pavement concrete shall be natural material complying with IS : 383 but with a Los Angeles Abrasion Test result not more than 35 per cent. The limits of deleterious materials shall not exceed the requirements set out in IS : 383.



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The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalis in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 per cent by weight and the total sulphate content expressed as sulphuric anhydride (SO_3) shall not exceed 0.25 per cent by weight.

i) Coarse aggregate

Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 25 mm for pavement concrete. Continuously graded or gap graded aggregates may be used, depending on the grading of the fine aggregate. No aggregate which has water absorption more than 2 per cent shall be used in the concrete mix. The aggregates shall be tested for soundness in accordance with IS : 2386 (Part-5). After 5 cycles of testing the loss shall not be more than 12 per cent if sodium sulphate solution is used or 18 percent if magnesium sulphate solution is used.

Dumping and stacking of aggregates shall be done in an approved manner. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hrs before batching as directed by the Engineer.

ii) Fine aggregate

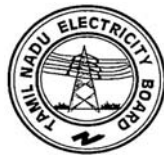
The fine aggregate shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS : 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregate shall not contain deleterious substances more than the following:

Clay lumps	4.0 percent
Coal and lignite	1.0 percent
Material passing IS Sieve No. 75 micron	4.0 percent
e) Water	

Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS : 456.

f) Mild steel bars for dowels and tie bars

These shall conform to the requirements of IS : 432, IS : 1139 and IS : 1786 as relevant. The dowel bars shall conform to Grade S 240 and tie bars to Grade S 415 of I.S.



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g) Premoulded joint filler

Joint filler board for expansion joints which are proposed for use only at some abutting structures like bridges and culverts shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirements of IS :1838, or BS Specification Clause No. 2630 of MOST standards or Specification for Highway Works, Vol .I Clause 1015. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit in the dowel bars.

h) Joint sealing compound

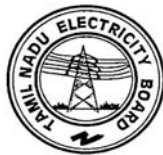
The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide type having flexibility, resistance to age hardening and durability. If the sealant is of hot poured type it shall conform to AASHTO M282 and cold applied sealant shall be in accordance with BS 5212 (Part 2).

i) Storage of materials

All materials shall be stored in accordance with the provisions of Clause 1014 of the MOST standards and other relevant IS Specifications. All effort must be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for the work. The platform where aggregates are stock piled shall be levelled with 15 cm of watered, mixed and compacted granular sub-base material. The area shall have slope and drain-to-drain off rainwater. The storage space must also permit easy inspection, removal and storage of the materials. Aggregates of different sizes shall be stored in partitioned stack-yards. All such materials even though stored in approved godowns must be subjected to acceptance test as per Clause 903 of MOST specifications immediately prior to their use.

20.03.02 Proportion of Concrete

After approval by the Engineer of all the materials to be used in the concrete, the Contractor shall submit the mix design based on weighed proportions of all ingredients for the approval of the Engineer. The mix design shall be submitted at least 30 days prior to the paving of trial length and the design shall be based on laboratory trial mixes using the approved materials and methods as per IS : 10262 (Recommended Guidelines for Mix Design) or on the basis of any other rational method agreed to by the Engineer. Guidance in this regard can also be obtained from IS : SP : 23 Handbook on Concrete Mixes. The target mean strength for the design mix shall be determined as indicated in Clause 903.5.2. of MOST standards. The mix design shall be based on the flexural strength of concrete.



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a) Cement content

The cement content shall not be less than 350 kg per cu.m. of concrete. If this minimum cement content is not sufficient to produce in the field, concrete of the strength specified in the drawings/design, it shall be increased as necessary without additional compensation under the Contract. The cement content shall, however, not exceed 425 kg per cu.m. of concrete.

b) Concrete strength

While designing the mix in the laboratory, correlation between flexural and compressive strengths of concrete shall be established on the basis of at least thirty tests on samples. However, quality control in the field shall be exercised on the basis of flexural strength. It may, however, be ensured that the materials and mix proportions remain substantially unaltered during the daily concrete production. The water content shall be the minimum required to provide the agreed workability for full compaction of the concrete to the required density as determined by the trial mixes or other means approved by the Engineer and the maximum free water cement ratio shall be 0.50.

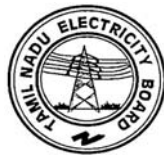
The ratio between the 7 and 28 day strengths shall be established for mix to be used in the slab in advance, by testing pairs of beams and cubes at each stage on at least six batches of trial mix. The average strength of the 7 day cured specimens shall be divided by the average strength of the 28 day specimens for each batch, and the ratio 'R' shall be determined. The ratio 'R' shall be expressed to three decimal places.

If during the construction of the trial length or during normal working, the average value of any four consecutive 7 day test results falls below the required 7 day strength as derived from the value of 'R', then the cement content of the concrete shall, without extra payment, be increased by 5 per cent by weight or by an amount agreed by the Engineer. The increased cement content shall be maintained at least until the four corresponding 28 day strengths have been assessed for its conformity with the requirements as per Clause 602.3.1 of MOST standards. Whenever the cement content is increased, the concrete mix shall be adjusted to maintain the required workability.

c) Workability

The workability of the concrete at the point of placing shall be adequate for the concrete to be fully compacted and finished without undue flow. The optimum workability for the mix to suit the paving plant being used shall be determined by the Contractor and approved by the Engineer. The control of workability in the field shall be exercised by the slump test as per IS : 1199.

The workability requirement at the Batching Plant and paving site shall be established slump tests carried during trial paving. These requirements shall be established from season to season and also when the lead from Batching plant site to the paving site changes. The workability shall be established for the type



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of paving equipment available. A slump value in the range of 30 ± 15 mm is reasonable for paving works but this may be modified depending upon the site requirement and got approved by the Engineer. These tests shall be carried out on every truck/dumper at Plant site and paving site initially when the work commences but subsequently the frequency can be reduced to alternate trucks or as per the instructions of the Engineer.

d) Design mix

The Contractor shall carry out laboratory trials of design mixes with the materials from the approved sources to be used. Trial mixes shall be made in presence of the Engineer or his representative and the design mix shall be subject to the approval of the Engineer. They shall be repeated if necessary until the proportions that will produce a concrete, which complies in all respects with this Specification, and conforms to the design/drawings have been determined.

The proportions determined as a result of the laboratory trial mixes may be adjusted if necessary during the construction of the trial length. Thereafter, neither the materials nor the mix proportions shall be varied in any way except with the written approval of the Engineer.

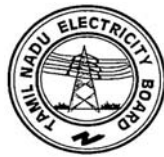
Any change in the source of materials or mix proportions proposed by the Contractor during the course of work shall be assessed by making laboratory trial mixes and the construction of a further trial length unless approval is given by the Engineer for minor adjustments like compensation for moisture content in aggregates or minor fluctuations in the grading of aggregate.

20.03.03 Sub-base

The cement concrete pavement shall be laid over the sub-base constructed in accordance with the relevant drawings and Specifications contained in Clause 601 of MOST standards. If the sub-base is found damaged at some places or it has cracks wider than 10mm, it shall be repaired with fine cement concrete or bituminous concrete laying separation layer. Prior to laying of concrete it shall be ensured that the separation membrane as per Clause 602.5 of MOST standards is placed in position and the same is clean of dirt or other extraneous materials and free from any damage.

20.03.04 Separation Membrane

A separation membrane shall be used between the concrete slab and the subbase. Separation membrane shall be impermeable plastic sheeting 125 microns thick laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheeting shall be replaced at the Contractor's expense. The separation membrane may be nailed to the lower layer with concrete nails.



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20.03.05 Joints

The location and type of joints shall be as shown in the drawing. Joint shall be constructed depending upon their functional requirement as detailed in the following paragraphs. The location of the joints should be transferred accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It should be ensured that the full required depth of cut is made from edge to edge of the pavement. Transverse and longitudinal joints in the pavement and sub-base shall be staggered so that they are not coincident vertically and are at least 1 m and 0.3 m apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and personnel without damaging the texture of the pavement. Sawing operation could start as early as 6-8 hours depending upon the season.

a) Transverse joints

Transverse joints shall be contraction and expansion joints constructed at the spacing described in the Drawings. Transverse joints shall be straight within the following tolerances along the intended line of joints which is the straight line transverse to the longitudinal axis of the carriageway at the position proposed by the Contractor and agreed to by the Engineer, except at road junctions or roundabouts where the position shall be as described in the drawings:

- (i) Deviations of the filler board in the case of expansion joints from the intended line of the joint shall not be greater than ± 10 mm.
- (ii) The best fit straight line through the joint grooves as constructed shall be not more than 25 mm from the intended line of the joint.
- (iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10 mm.
- (iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width. Transverse joints shall have a sealing groove which shall be sealed in compliance with Clause 602.11.

b) Contraction joints

Contraction joints shall consist of a mechanical sawn joint groove, 3 to 5 mm wide and 1/4 to 1/3 depth of the slab ± 5 mm or as stipulated in the drawings and dowel bars complying with Clause 602.6.5 of MOST standards and as detailed in the drawings.

The contraction joints shall be cut as soon as the concrete has undergone initial hardening and is hard enough to take the load of joint sawing machine without causing damage to the slab.



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c) Expansion joints

The expansion joints shall consist of a joint filler board complying with Clause 602.2.7 of MOST standards and dowel bars complying with Clause 602.6.5 of MOST standards and as detailed in the drawings. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within the tolerances given in Clause 602.6.2.1 of MOST standards and at such depth below the surface as will not impede the passage of the finishing straight edges or oscillating beams of the paving machines. The adjacent slabs shall be completely separated from each other by providing joint filler board. Space around the dowel bars, between the sub-base and the filler board shall be packed with a suitable compressible material to block the flow of cement slurry.

d) Transverse construction joint

Transverse construction joints shall be placed whenever concreting is completed after a day's work or is suspended for more than 30 minutes. These joints shall be provided at the regular location of contraction joints using dowel bars. The joint shall be made butt type. At all construction joints, steel bulk heads shall be used to retain the concrete while the surface is finished. The surface of the concrete laid subsequently shall conform to the grade and cross sections of the previously laid pavement. When positioning of bulk head/stop-end is not possible, concreting to an additional 1 or 2 m length may be carried out to enable the movement of joint cutting machine so that joint grooves may be formed and the extra 1 or 2 m length is cut out and removed subsequently after concrete has hardened.

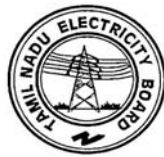
e) Longitudinal joint

The longitudinal joints shall be saw cut as per details of the joints shown in the drawing. The groove may be cut after the final set of the concrete. Joints should be sawn to at least $\frac{1}{3}$ the depth of the slab ± 5 mm as indicated in the drawing.

Tie bars shall be provided at the longitudinal joints as per dimensions and spacing shown in the drawing and in accordance with Clause 602.6.6 of MOST standards.

20.03.06 Dowel bars

Dowel bars shall be mild steel rounds in accordance with Clause 602.2.6 of MOST standards with details/dimensions as indicated in the drawing and free from oil, dirt, loose rust or scale. They shall be straight, free of irregularities and burring restricting slippage in the concrete. The sliding ends shall be sawn or cropped cleanly with no protrusions outside the normal diameter of the bar. The dowel bar shall be supported on cradles/dowel chairs in pre-fabricated joint



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assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full re-compaction of the concrete around the dowel bars.

Unless shown otherwise on the drawings, dowel bars shall be positioned at mid depth of the slab within a tolerance of ± 20 mm, and centered equally about intended lines of the joint within a tolerance of ± 25 mm. They shall be aligned parallel to the finished surface of the slab and to the centre line of the carriageway and to each other within tolerances given hereunder, the compliance of which shall be checked as per Clause 602.10.7 of MOST standards.

- (i) For bars supported on cradles prior to the laying of the slab:
 - (a) All bars in a joint shall be within ± 3 mm per 300 mm length of bar
 - (b) 2/3rd of the bars shall be within ± 2 mm per 300 mm length of bar
 - (c) No bar shall differ in alignment from an adjoining bar by more than 3 mm per 300 mm length of bar in either the horizontal or vertical plane
 - (d) Cradles supporting dowel bar shall not extend across the line of joint i.e. no steel bar of the cradle assembly shall be continuous across the joint.
- (ii) For all bars inserted after laying of the slab:
 - (a) Twice the tolerance for alignment as indicated in (i) above

Dowel bars, supported on cradles in assemblies, when subject to a load of 110 N applied at either end and in either the vertical or horizontal direction (upwards and downwards and both directions horizontally) shall conform to be within the following limits:

- (i) Two-thirds of the number of bars of any assembly tested shall not deflect more than 2 mm per 300 mm length of bar
- (ii) The remainder of the bars in that assembly shall not deflect more than 3 mm per 300 mm length of bar.

The assembly of dowel bars and supporting cradles, including the joint filler board in the case of expansion joints, shall have the following degree of rigidity when fixed in position:-

- (i) For expansion joints, the deflection of the top edge of the filler board shall be not greater than 13 mm, when a load of 1.3 kN is applied perpendicular to the vertical face of the joint filler board and distributed over a length of 600 mm by means of a bar or timber packing, at mid depth and midway between individual fixings, or 300 mm from either end of any length of filler board, if a continuous fixing, is used. The



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residual deflection after removal of the load shall be not more than 3 mm.

- (ii) The joint assembly fixings to sub-base shall not fail under the 1.3 kN load applied for testing the rigidity of the assembly but shall fail before the load reaches 2.6 kN.
- (iii) The fixings for contraction joint shall not fail under 1.3 kN load and shall fail before the load reaches 2.6 kN when applied over a length of 600 mm by means of a bar or timber packing placed as near to the level of the line of fixings as practicable.
- (iv) Fixings shall be deemed to fail when there is displacement of the assemblies by more than 3mm with any form of fixing, under the test load. The displacement shall be measured at the nearest part of the assembly to the centre of the bar or timber packing.

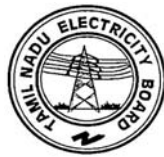
Dowel bars shall be covered by a thin plastic sheath for at least two-thirds of the length from one end for dowel bars in contraction joints or half the length plus 50 mm for expansion joints. The sheath shall be tough, durable and of an average thickness not greater than 1.25 mm. The sheathed bar shall comply with the following pull-out tests:

- i. Four bars shall be taken at random from stock and without any special preparation shall be covered by sheaths as required in this Clause. The ends of the dowel bars which have been sheathed shall be cast centrally into concrete specimens 150 x 150 x 600 mm, made of the same mix proportions to be used in the pavement, but with a maximum nominal aggregate size of 20 mm and cured in accordance with IS:516. At 7 days a tensile load shall be applied to achieve a movement of the bar of at least 0.25 mm. The average bond stress to achieve this movement shall not be greater than 0.14 MPa.

For expansion joints, a closely fitting cap 100 mm long consisting of waterproofed card board or an approved synthetic material like PVC or GI pipe shall be placed over the sheathed end of each dowel bar. An expansion space at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of cement slurry between dowel and cap it may be taped.

20.03.07 Tie bars

Tie bars in longitudinal joints shall be deformed steel bars of strength 415 MPa complying with IS:1786 and in accordance with the requirements given below. The bars shall be free from oil, dirt, loose rust and scale.



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Tie bars projecting across the longitudinal joint shall be protected from corrosion for 75 mm on each side of the joint by a protective coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used.

Tie bars in longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of the slab. Alternatively, tie bars at longitudinal joint may be mechanically or manually inserted into the plastic concrete from above by vibration using a method which ensures correct placement of the bars and recompaction of the concrete around the tie bars.

Tie bars shall be positioned to remain within the middle third of the slab depth as indicated in the drawings and approximately parallel to the surface and approximately perpendicular to the line of the joint, with the centre of each bar on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30 mm below the joint groove.

20.03.08 Weather and Seasonal Limitations

a) Concrete during monsoon months

When concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulin or other water proof cloth shall be provided along the line of the work. Any time when it rains, all freshly laid concrete which had not been covered for curing purposes shall be adequately protected. Any concrete damaged by rain shall be removed and replaced. If the damage is limited to texture, it shall be retextured in accordance with the directives of the Engineer.

b) Concreting in hot weather

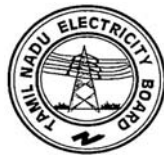
No concreting shall be done when the concrete temperature is above 30 degree Centigrade. Besides, in adverse conditions like high temperature, low relative humidity, excessive wind velocity, imminence of rains etc., if so desired by the Engineer, tents on mobile trusses may be provided over the freshly laid concrete for a minimum period of 3 hours as directed by the Engineer. The temperature of the concrete mix on reaching the paving site shall not be more than 30°C. To bring down the temperature, if necessary, chilled water or ice flakes should be made use of.

No concreting shall be done when the concrete temperature is below 5 degree Centigrade and the temperature is descending.

20.03.09 Side Forms, Rails and Guidewires

a) Side forms and rails

All side forms shall be of mild steel of depth equal to the thickness of pavement or slightly less to accommodate the surface regularity of the sub-base. The



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forms can be placed on series of steel packing plates or shims to take care of irregularity of sub-base. They shall be sufficiently robust and rigid to support the weight and pressure caused by a paving equipment. Side forms for use with wheeled paving machines shall incorporate metal rails firmly fixed at a constant height below the top of the forms. The forms and rail shall be firmly secured in position by not less than 3 stakes/pins for each 3m length so as to prevent movement in any direction. Forms and rails shall be straight within a tolerance of 3 mm in 3m and when in place shall not settle excess of 1.5 mm in 3 m while paving is being done. Forms shall be cleaned and oiled immediately before each use. The forms shall be bedded on a continuous bed of low moisture content lean cement mortar or concrete and set to the line and levels shown on the drawings within tolerances ± 10 mm and ± 3 mm respectively. The bedding shall not extend under the slab and there shall be no vertical step between adjacent forms of more than 3 mm. The forms shall be got inspected from the Engineer for his approval before 12 hours on the day before the construction of the slab and shall not be removed until at least 12 hours afterwards.

At all times sufficient forms shall be used and set to the required alignment for at least 200 m length of pavement immediately in advance of the paving operations, or anticipated length of pavement to be laid within the next 24 hrs whichever is more.

b) Use of guide wires

Where slip form paving is proposed, a guide wire shall be provided along both sides of the slab. Each guide wire shall be at a constant height above and parallel to the required edges of the slab as described in the contract/drawing within a vertical tolerance of ± 3 mm. Additionally, one of the wires shall be kept at a constant horizontal distance from the required edge of the pavement as indicated in the contract/drawing within a lateral tolerance of ± 10 mm.

The guide wires shall be supported on stakes not more than 8 m apart by connectors capable of fine horizontal and vertical adjustment. The guide wire shall be tensioned on the stakes so that a 500 gram weight shall produce a deflection of not more than 20 mm when suspended at the mid point between any pair of stakes. The ends of the guide wires shall be anchored to fixing point or winch and not on the stacks.

The stack shall be positioned and the connectors maintained at their correct height and alignment from 12 hours on the day before concreting takes place until 12 hours after finishing of the concrete. The guidewire shall be erected and tensioned the connectors at any section for at least 2 hours before concreting that section.

The Contractor shall submit to the Engineer for his approval of line and level, the stakes and connectors which are ready for use in the length of road to be constructed by 12 hours on the working day before the day of construction of slab. Any deficiencies noted by the Engineer shall be rectified by the Contractor who shall then re-apply for approval of the affected stakes. Work shall not



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proceed until the Engineer has given his approval. It shall be ensured that the stakes and guidewires are not affected by the construction equipment when concreting is in progress.

20.03.10 Construction

A systems approach may be adopted for construction of the pavement, and the Method Statement for carrying out the work, detailing all the activities including indication of time-cycle, equipment, personnel etc., shall be got approved from the Engineer before the commencement of the work. The above shall include the type, capacity and make of the batching and mixing plant besides the hauling arrangement and paving equipment. The capacity of paving equipment, batching plant as well as all the ancillary equipment shall be adequate for a paving rate of at least 300 m in one day.

a) Batching and mixing

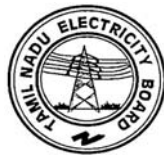
Batching and mixing of the concrete shall be done at a central batching and mixing plant with automatic controls, located at a suitable place which takes into account sufficient space for stockpiling of cement, aggregates and stationary water tanks. This shall be, however, situated at an approved distance, duly considering the properties of the mix and the transporting arrangements available with the Contractor.

b) Equipment for proportioning of materials and paving

Proportioning of materials shall be done in the batching plant by weight, each type of material being weighed separately. The cement from the bulk stock may be weighed separately from the aggregates and water shall be measured by volume. Wherever properly graded aggregate of uniform quality cannot be maintained as envisaged in the mix design, the grading of aggregates shall be controlled by appropriate blending techniques. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity of the laying/paving equipment.

Batching plant and equipment:

- (1) General-** The batching plant shall include minimum four bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dust during operation. Approved safety devices shall be provided and maintained for the protection of all personnel engaged in plant operation, inspection and testing. The batch plant shall be equipped with suitable non-resettable batch counter which will correctly indicate the number of batches proportioned.
- (2) Bins and hoppers-** Bins with minimum number of four adequate separate compartments shall be provided in the batching plant.



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- (3) Automatic weighing devices- Batching plant shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices using load cells.
- (4) Mixers- Mixers shall be pan type, reversible type or any other mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specific mixing period, and of discharging the mixture, without segregation. Each stationary mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. The device shall be equipped with a bell or other suitable warning device adjusted to give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed 90 seconds or as per the manufacturer's recommendation. The mixer shall be equipped with a suitable non-resettable batch counter which shall correctly indicate the number of batches mixed.

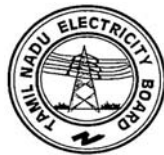
The mixers shall be cleared at suitable intervals. The pickup and throw-over blades in the drum or drums shall be repaired or replaced when they are worn down 20 mm or more. The Contractor shall (1) have available at the job site a copy of the manufacturer's design, showing dimensions and arrangements of blades in reference to original height and depth, or (2) provide permanent marks on blade to show points of 20 mm wear from new conditions. Drilled holes of 5 mm diameter near each end and at mid point of each blade are recommended. Batching Plant shall be calibrated in the beginning and thereafter at suitable interval not exceeding 1 month.

(5)Control cabin- An air-conditioned centralised control cabin shall be provided for automatic operation of the equipment.

Paving equipment

The concrete shall be placed with an approved fixed form or slip paver with independent units designed to (i) spread, (ii) consolidate, screed and float-finish, (iii) texture and cure the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary and so as to provide a dense and homogeneous pavement in conformity with the plans and Specifications. The paver shall be equipped with electronic controls to control/sensor line and grade from either or both sides of the machine.

Vibrators shall operate at a frequency of 8300 to 9600 impulses per minute under load at a maximum spacing of 60 cm. The variable vibration setting shall be provided in the machine.



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Concrete saw

The Contractor shall provide adequate number of concrete saws with sufficient number of diamond-edge saw blades. The saw machine shall be either electric or petrol/diesel driven type. A water tank with flexible hoses and pump shall be made available in this activity on priority basis. The Contractor shall have at least one standby saw in good working condition. The concreting work shall not commence if the saws are not in working condition.

c) Hauling and placing of concrete

Freshly mixed concrete from the central batching and mixing plant shall be transported to the paver site by means of trucks/tippers of sufficient capacity and approved design in sufficient numbers to ensure a constant supply of concrete. Covers shall be used for protection of concrete against the weather. The trucks/tippers shall be capable of maintaining the mixed concrete in a homogeneous state and discharging the same without segregation and loss of cement slurry. The feeding to the paver is to be regulated in such a way that the paving is done in an uninterrupted manner with a uniform speed throughout the days work.

Placing of concrete

Concrete mixed in central mixing plant shall be transported to the site without delay and the concrete which, in the opinion of the Engineer, has been mixed too long before laying will be rejected and shall be removed from the site. The total time taken from the addition of the water to the mix, until the completion of the surface finishing and texturing shall not exceed 120 minutes when concrete temperature is less than 25°C and 90 minutes when the concrete temperature is between 25°C to 30°C. Trucks/tippers delivering concrete shall not run on plastic sheeting nor shall they run on completed slabs until after 28 days of placing the concrete. The Paver shall be capable of paving the carriageway as shown in the drawings, in a single pass and lift.

Where fixed form pavers are to be used, forms shall be fixed in advance as per Clause 602.8 of the MOST standards. Before any paving is done, the site shall be shown to the Engineer, in order to verify the arrangement for paving besides placing of dowels, tie-bars etc., as per the relevant Clauses of this Specification. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement.

In all cases, the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.

The addition of water to the surface of the concrete to facilitate the finishing operations will not be permitted except with the approval of the Engineer when it shall be applied as a mist by means of approved equipment.



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If considered necessary by the Engineer, the paving machines shall be provided with approved covers to protect the surface of the slab under construction from direct sunlight and rain or hot wind.

While the concrete is still plastic, its surface shall be brush textured in compliance with Clause 602.9.8 of MOST specifications and the surface and edges of the slab cured by the application of a sprayed liquid curing membrane in compliance with Clause 602.9.9 of MOST specifications. After the surface texturing, but before the curing compound is applied, the concrete slab shall be marked with the chainage at every 100 m interval.

As soon as the side forms are removed, edges of the slabs shall be corrected wherever irregularities have occurred by using fine concrete composed of one part of cement to 3 parts of fine chips and fine aggregate under the supervision of the Engineer.

If the requirement of Clause 902.4. of MOST specifications for surface regularity fails to be achieved on two consecutive working days, then normal working shall cease until the cause of the excessive irregularity has been identified and remedied.

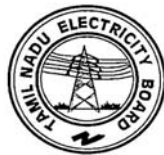
d) Construction by fixed form paver

The fixed form paving train shall consist of separate powered machines which spread, compact and finish the concrete in a continuous operation.

The concrete shall be discharged without segregation into a hopper spreader which is equipped with means for controlling its rate of deposition on to the subbase. The spreader shall be operated to strike off concrete upto a level requiring a small amount of cutting down by the distributor of the spreader. The distributor of spreader shall strike off the concrete to the surcharge adequate to ensure that the vibratory compactor thoroughly compacts the layer. If necessary, poker vibrators shall be used adjacent to the side forms and edges of the previously constructed slab. The vibratory compactor shall be set to strike off the surface slightly high so that it is cut down to the required level by the oscillating beam. The machine shall be capable of being rapidly adjusted for changes in average and differential surcharge necessitated by changes in slab thickness or cross fall. The final finisher shall be able to finish the surface to the required level and smoothness as specified, care being taken to avoid bringing up of excessive mortar to the surface by overworking.

e) Construction by slip form paver

The slip form paving train shall consist of power machine which spreads compacts and finishes the concrete in a continuous operation. The slip form paving machine shall compact the concrete by internal vibration and shape it between the side forms with either a conforming plate or by vibrating and oscillating finishing beams. The concrete shall be deposited without segregation in front of slip form paver across the whole width and to a height



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which at all times is in excess of the required surcharge. The deposited concrete shall be struck off to the necessary average and differential surcharge by means of the strike off plate or a screw auger device extending across the whole width of the slab. The equipment for striking-off the concrete shall be capable of being rapidly adjusted for changes of the average and differential surcharge necessitated by change in slab thickness or cross fall.

The level of the conforming plate and finishing beams shall be controlled automatically from the guide wires installed as per Clause 602.8 of MOST specifications by sensors attached at the four corners of the slip form paving machine. The alignment of the paver shall be controlled automatically from the guide wire by at least one set of sensors attached to the paver. The alignment and level of ancillary machines for finishing, texturing and curing of the concrete shall be automatically controlled relative to the guide wire or to the surface and edge of the slab.

Slip-form paving machines shall have vibrators of variable output, with a maximum energy output of not less than 2.5 KW per metre width of slab per 300 mm depth of slab for a laying speed upto 1.5 m per minute or pro-rata for higher speeds. The machines shall be of sufficient mass to provide adequate reaction during spreading and paving operations on the traction units to maintain forward movements during the placing of concrete in all situations.

If the edges of the slip formed slab slump to the extent that the surface of the top edge of the slab does not comply with the requirements of Clause 602.14 of MOST specifications, then special measures approved by the Engineer shall be taken to support the edges to the required levels and work shall be stopped until such time as the Contractor can demonstrate his ability to slip form the edges to the required levels.

f) Construction by hand-guided method

Areas in which hand-guided methods of construction become indispensable shall be got approved by the Engineer in writing in advance. Such work may be permitted only in restricted areas in small lengths. Work shall be carried out by skilled personnel as per methods approved by the Engineer. The acceptance criteria regarding level, thickness, surface regularity, texture, finish, strength of concrete and all other quality control measures shall be the same as in the case of machine laid work.

g) Surface texture

After the final regulation of the slab and before the application of the curing membrane, the surface of concrete slab shall be brush-textured in a direction at right angles to the longitudinal axis of the carriageway.

The brushed surface texture shall be applied evenly across the slab in one direction by the use of a wire brush not less than 450 mm wide but longer brushes are preferred. The brush shall be made of 32 gauge tape wires grouped together in tufts spaced at 10 mm centres. The tufts shall contain an



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average of 14 wires and initially be 100 mm long. The brush shall have two rows of tufts. The rows shall be 20 mm apart and the tufts in one row shall be opposite the centre of the gap between tufts in the other row. The brush shall be replaced when the shortest tuft wears down to 90 mm long.

The texture depth shall be determined by the Sand Patch Test as described in Clause 602.12 of MOST specifications. This test shall be performed at least once for each day's paving and wherever the Engineer considers it necessary at times after construction as under:

Five individual measurements of the texture depth shall be taken at least 2 m apart anywhere along a diagonal line across a lane width between points 50 m apart along the pavement. No measurement shall be taken within 300 mm of the longitudinal edges of a concrete slab constructed in one pass.

Texture depths shall not be less than the minimum required when measurements are taken as given in Table below nor greater than a maximum average 1.25 mm.

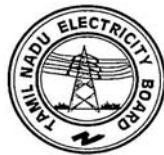
TABLE : Texture Depth

Time of Test	Number of Measurements	Required Texture Depth (mm)	
		Specified Value	Tolerance
1. Between 24 hours and 7 days after the constn., of the slab or until the slab is first used by vehicles.	An average of 5 measurements	1.00	0.25
2. Not later than 6 weeks before the road is opened to public traffic.	An average of 5 measurements	1.00	+0.25 -0.35

After the application of the brushed texture, the surface of the slab shall have a uniform appearance.

Where the texture depth requirements are found to be deficient, the Contractor shall make good the texture across the full lane width over length directed by the Engineer, by retexturing the hardened concrete surface in an approved manner.

h) Curing



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Immediately after the surface texturing, the surface and sides of the slab shall be cured by the application of approved resin-based aluminised reflective curing compound which hardens into an impervious film or membrane with the help of a mechanical sprayer.

Curing compounds shall contain sufficient flake aluminium in finely divided dispersion to produce a complete coverage of the sprayed surface with a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have a water retention efficiency index of 90 per cent in accordance with BS Specification No. 7542.

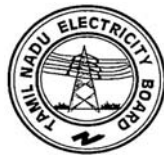
The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks after application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying.

In addition to spraying of curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavement with tents as described in Clause 602.7.2, during adverse weather conditions as directed by the Engineer. After three hours, the pavement shall be covered by moist hessian and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. The hessian shall be kept continuously moist. All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

The Contractor shall be liable at his expense to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint.

20.03.11 Trial Length

The trial length shall be constructed at least one month in advance of the proposed start of concrete paving work. At least one month prior to the construction of the trial length, the Contractor shall submit for the Engineer's approval a detailed method statement giving description of the proposed materials, plant, equipment and construction methods. All the major equipments like paving train, batching plant, tippers etc., proposed in the construction are to be approved by the Engineer before their procurement. No trials of new materials, plant, equipment or construction methods, nor any development of them shall be permitted either during the construction of trial length or in any subsequent paving work, unless they form part of further, approved trials. These trial lengths shall be constructed away from the carriageway but with at least a subbase layer below it.



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The Contractor shall demonstrate the materials, plant, equipment and methods of construction that are proposed for concrete paving, by first constructing a trial length of slab, at least 60 m but not more than 300 m long for mechanised construction and at least 30 m long for hand guided methods. If the first trial is unsatisfactory, the Contractor shall have to demonstrate his capability to satisfactorily construct the pavement in subsequent trials.

The trial length shall be constructed in two parts over a period comprising at least part of two separate working days, with a minimum of 30 m constructed each day for mechanised construction and a minimum of 15 m on each day for hand guided construction. The trial length shall be constructed at a similar rate (speed, around 1m/hr) to that which is proposed for the main work.

Transverse joints and longitudinal joints of each type that are proposed for dowel-jointed unreinforced concrete slabs in the main work shall be constructed and assessed in the trial length. If in the trial length the construction of expansion joint and longitudinal joint is not demonstrated, the first 2 expansion joints and at least the first 150 m of longitudinal construction joint for mechanised paving in the main work, shall be considered as the trial length for these joints.

The trial length shall comply with the Specification in all respects, with the following additions and exceptions:

a) Surface levels and regularity

(i) In checking for compliance with Clause 903.5 the levels shall be taken at intervals at the locations specified in this Clause along any line or lines parallel to the longitudinal centre line of the trial length.

(ii) The maximum number of permitted irregularities of pavement surface shall comply with the requirements of Clause 902.4. Shorter trial lengths shall be assessed pro-rata based on values for a 300 m length.

b) Joints

Alignment of dowel bars shall be inspected as described in Clause 602.10.7 in any two consecutive transverse joints. If the position or alignment of the dowel bars at one of these joints does not comply with Clause 602.6.5, if that joint remains the only one that does not comply after the next 3 consecutive joints of the same type have been inspected, then the method of placing dowels shall be deemed to be satisfactory. In order to check sufficient joints for dowel bar alignment without extending the trial length unduly, the Contractor may, by agreement with the Engineer, construct joints at more frequent joint intervals than the normal spacing required in the Contract.

If there are deficiencies in the first expansion joint that is constructed as a trial, the next expansion joint shall be a trial joint. Should this also be deficient, further



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trial expansion joints shall be made as part of the trial length which shall not form part of the permanent works, unless agreed by the Engineer.

c) Density

Density shall be assessed as described in Clause 602.3.3. from at least 3 cores drilled from each part of the trial length.

d) Position of tie bars

Compliance with Clause 602.6.6 for the position and alignment of tie bars shall be checked by drilling additional cores from the slab unless they can be determined from cores taken for density.

e) Approval and acceptance

Approval of the materials, plant, equipment and construction methods shall be given when a trial length complies with the Specification. The Contractor shall not proceed with normal working until the trial length has been approved and any earlier defective trial lengths have been removed, unless that can be remedied to the satisfaction of the Engineer. If the Engineer does not notify the Contractor of any deficiencies in any trial length within 10 days after the completion of that trial length, the Contractor may assume that the trial length, and the materials, plant, equipment and construction methods adopted are acceptable.

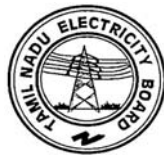
When approval has been given, the materials, plant, equipment and construction methods shall not thereafter be changed, except for normal adjustments and maintenance of plant, without the approval of the Engineer. Any changes in material, plant, equipment and construction methods shall entitle the Engineer to require the Contractor to lay a further trial length as described in this Clause to demonstrate that the changes will not adversely affect the permanent works.

Trial lengths which do not comply with the Specification, with the exception of areas which are deficient only in surface texture and which can be remedied in accordance with Clause 602.9.8.6 of MOST specifications shall be removed immediately upon notification of deficiencies by the Engineer and the Contractor shall construct a further trial length.

f) Inspection of dowel bars

Compliance with Clause 602.6.5 of MOST specifications for the position and alignment of dowel bars at construction and expansion joints shall be checked by measurements relative to the side forms or guide wires.

When the slab has been constructed, the position and alignment of dowel bars and any filler board shall be measured after carefully exposing them in the plastic concrete across the whole width of the slab. When the joint is an expansion joint, the top of the filler board shall first be exposed sufficiently in



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the plastic concrete to permit measurement of any lateral or vertical displacement of the board. During the course of normal working, these measurements shall be carried out in the pavement section at the end of day's work by extending slab length by 2 m. After sawing the transverse joint groove, the extended 2 m slab shall be removed carefully soon after concrete has set to expose dowels over half the length. These dowels can be tested for tolerances.

If the position and alignment of the bars in a single joint in the slab is unsatisfactory then the next two joints shall be inspected. If only one joint of the three is defective, the rate of checking shall be increased to one joint per day until the Engineer is satisfied that compliance is being achieved. In the event of non-compliance in two or more successive joints, the Contractor shall revert to the construction of fresh trial lengths and make any necessary alteration to concrete mix, paving plant or methods until the dowel bar position and alignment are satisfactory.

After the dowel bars have been examined, the remainder of the concrete shall be removed over a width of 500 mm on each side of the line of the joint and reinstated to the satisfaction of the Engineer. The dowels shall be inserted on both sides of the 1 m wide slab by drilling holes and grouting with epoxy mortar. Plastic sheath as per Clause 602.6.5.5 of MOST specifications shall be provided on dowels on one of the joints. The joint groove shall be widened and sealed as per Clause 602.11 of MOST specifications.

20.03.12 Preparation and Sealing of Joint Grooves

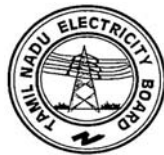
a) General

All transverse joints in surface slabs shall be sealed using sealants described in Clause 602.2.8 of MOST specifications. Joints shall not be sealed before 14 days after construction.

b) Preparation of joint grooves for sealing

Joint grooves usually are not constructed to provide the minimum width specified in the drawings when saw cut joints are adopted. They shall be widened subsequently by sawing before sealing. Depth/width gauges shall be used to control the dimension of the groove.

If rough arises develop when grooves are made, they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle upto 10 degree from the perpendicular to the surface, the overhanging edge of the sealing groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10 degrees, the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects upto a maximum width, including any chamfer, of 35 mm for transverse joints and 20 mm for longitudinal joints. If the spalling cannot be so eliminated then the



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arises shall be repaired by an approved thin bonded aris repair using cementitious materials.

All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. If need arises the Engineer may instruct cleaning by pressurised water jets. Depending upon the requirement of the sealant manufacture, the sides of the grooves may have to be sand blasted to increase the bondage between sealant and concrete.

The groove shall be cleaned and dried at the time of priming and sealing.

Before sealing the temporary seal provided for blocking the ingress of dirt, soil etc., shall be removed. A highly compressible heat resistant paper-backed debonding strip as per drawing shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove so that the sealant may not leak through the cracks. The width of debonding strip shall be more than the joint groove width so that it is held tightly in the groove. In the case of longitudinal joints, heat resistant tapes may be inserted to block the leakage through bottom of the joint.

c) Sealing with sealants

When sealants are applied, an appropriate primer shall also be used if recommended by the manufacturer and it shall be applied in accordance with their recommendation. The sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed is below 7°C.

If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculating pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturers' recommendations and reheated material shall not be used.

Cold applied sealants with chemical formulation like polysulphide may be used. These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended they shall be applied neatly with an appropriate brush. The Movement Accommodation Factor (MAF) shall be more than 10 per cent

The sealants applied at contraction phase of the slabs would result in bulging of the sealant over and above the slab. Therefore, the Contractor in consultation with the Engineer shall establish the right temperature and time for



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applying the sealant. Thermometer shall be hung on a pole in the site for facilitating control during the sealing operation.

Sealant shall be applied, slightly to a lower level than the slab with a tolerance of 5 ± 2 mm.

During sealing operation, it shall be seen that no air bubbles are introduced in the sealant either by vapors or by the sealing process.

d) Testing of applied sealants

Manufacturer's certificate shall be produced by the Contractor for establishing that the sealant is not more than six months old and stating that the sealant complies with the relevant standard as in Clause 602.2.8. The samples shall meet the requirement of AASHTO M 282 for hot applied sealant or BS 5212 : (Part- 2) for cold applied sealant.

e) Measurement of Texture Depth - Sand Patch Method

The following apparatus shall be used:

- (i) A cylindrical container of 25 ml internal capacity
- (ii) A flat wooden disc 64 mm diameter with a hard rubber disc, 1.5 mm thick, stuck to one face, the reverse face being provided with a handle.
- (iii) Dry natural sand with a rounded particle shape passing a 300 micron IS sieve and retained on a 150 micron IS sieve.

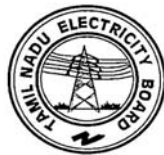
d) Method

The surface to be measured shall be dried, any extraneous mortar and loose material removed and the surface swept clean using a wire brush both at right angles and parallel to the carriageway. The cylindrical container shall be filled with the sand, tapping the base 3 times on the surface to ensure compaction, and striking off the sand level with the top of the cylinder. The sand shall be poured into a heap on the surface to be treated. The sand shall be spread over the surface, working the disc with its face kept flat in a circular motion so that the sand is spread into a circular patch with the surface depressions filled with sand to the level of peaks.

The diameter of the patch shall be measured to the nearest 5 mm. The texture depth of concrete surface shall be calculated from $31000/(D \times D)$ mm where D is the diameter of the patch in mm.

20.03.13 Opening to Traffic

No vehicular traffic shall be allowed to run on the finished surface of a concrete pavement within a period of 28 days of its construction and until the joints are permanently sealed. The road may be opened to regular traffic after completion



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of the curing period of 28 days and after sealing of joints is completed including the construction of shoulder, with the written permission of the Engineer.

20.03.14 Tolerance for Surface Regularity, Level, Thickness and Strength

The tolerances for surface regularity, level, thickness and strength shall conform to the requirements given in Clause 903.5 of MOST specifications. Control of quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MOST specifications.

21 CHAIN LINK FENCING

SCOPE

This specification covers furnishing of all labor, supervision, materials, tools, equipment and services necessary for or incidental to the fabrication and installation of the Fencing in accordance with the drawings and as specified herein.

The following work shall be included :

Chain link fences

Gates

Foundations

Padlocks

21.01.00 Materials / Details

21.01.01 PVC coated chain link fencing of mesh size 75 mm to a height of 2.4 m above the toe wall with a 600 mm high galvanised concertina at the top such that total fence height of 3.0 m above toe wall level is achieved.

21.01.02 Toe wall shall be minimum 200 mm above finished grade level.

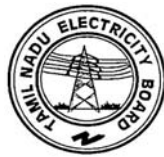
21.01.03 The chain link will be stretched and attached by 'C' clips at 0.5 m intervals to 3 strands of high tensile spring steel wire (HTSSW) of 12 gauge interwoven in chain link wire mesh and kept under tension which in turn are attached to the fence post with security galvanised nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security galvanised nuts and bolts.



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- 21.01.04 Above the chain link a 600 mm high Tensile Serrated Wire (HTSW) galvanised concertina will be stretched to 6 m and attached to 2 strands HTSS wire by means of 'C' clips at 1 m intervals. The 2 HTSS wire strands will be attached to angle iron posts concrete with 12mm security fasteners.
- 21.01.05 All fence posts shall be 65 x 65 x 6 MS angles spaced at 2.5 m C/C distance. All straining posts i.e., end posts shall be 65 x 65 x 6 MS angles. All corner posts will have two stay posts and every tenth post will have a transverse stay post. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions
- 21.01.06 Toe walls either of brick masonry with bricks of minimum 50 kg/cm² compressive strength shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the finished grade level with PCC coping (1:2:4). All gates shall be of hot dip galvanised structural steel as per specification.
- 21.01.07 All structural steel work for the fencing shall be painted with synthetic enamel paint over a suitable primer or two coats of epoxy paint depending upon site condition.
- 21.01.08 Galvanising All structural steel works including members for towers, gantries, equipment supporting structures and gates shall be hot dip galvanised after fabrication in accordance with relevant Indian Standard Codes.
- Zinc required for galvanising will have to be arranged for by the Contractor. Purity of zinc to be used for galvanising shall be 99.5% as per IS:209.
- The weight of the zinc coating shall be at least 0.610 kg/m² unless noted otherwise. Stub members, anchor bolts shall be having heavier zinc coating not less than 0.80 kg/m².
- Fasteners, bolts, washers etc. shall have zinc coating as per relevant IS Code unless specified otherwise.
- 21.01.09 The Fencing post including stays and corner braces may be of precast concrete of shape and size furnished for steel post above the grade of Reinforced concrete shall not be less than M-25 with foundation as per site conditions. The cross section of area of the post shall not be less than 150mm x 150mm reinforced with 4Nos. of 10mm longitudinal bar with closed stirrups of 8mm Dia.bar at 150mm c/c.
- 21.02.00 Installation
- 21.02.01 Installation shall be in accordance with manufacturer's instructions. Corners shall be square where required. Posts shall be aligned in the horizontal and vertical directions.
- 21.02.02 Fabric shall be in tension so as to eliminate sagging.
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21.02.03 Posts shall not deflect in any direction thereby causing gates not to close properly.

21.02.04 Hold open and meeting stop shall be provided for all gates, securely anchored into the ground and/or pavement.

21.03.00 Shop Drawings

21.03.01 Shop drawings shall be submitted for approval prior to fabrication and delivery of materials. Shop drawings shall indicate the following minimum information:

Types and gages of materials

Plan and layout of total fencing

Location, fabrication and sizes of gates

Typical sections through fencing

Bracing locations

Details of foundations

21.03.02 Approval of shop drawings will be for arrangement only and shall not relieve the Contractor of the responsibility for errors, omissions or the accuracy of his own dimensions.

22.00.00 **LAND SCAPING**

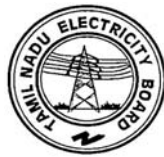
22.01.00 General

This specification covers broadly the requirements for Landscaping within the Plant Area. Landscaping shall be carried out after all the underground utilities and drainage systems are in place. The entire work of Landscaping shall be carried out to the satisfaction of the Engineer and in a manner to have a beautiful appearance after completion of the work.

Before the site grading is started the contractor shall prepare a plan for Landscaping and get it approved from the Engineer. The Landscaping plan should be prepared by the Contractor with the help of an expert horticulturist with due considerations for Fauna & Flora grown in the adjacent area and which can sustain in the saline climate.

The area to be landscaped shall be clearly demarcated at site and got approved by the Engineer.

The work shall be divided into following sub-items.



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22.01.01 Preparing Lawn

For this purpose, within the area where lawn is to be grown, about 0.3 metres of earth shall be removed. This shall be replaced by fresh garden soil and manure in 2: 1 proportions spread evenly. Fresh garden soil & manure shall be mixed thoroughly, well watered and left overnight. The next morning, the variety of lawn, as per approved plan and as directed by the Engineer, shall be planted. This grass shall be maintained till well established by watering, weeding, clipping, rolling etc

22.01.02 PREPARING CLIPPED HEDGES

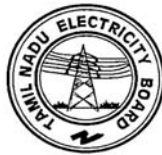
Hedges made of Casuarinas or other shrubs as directed by the Engineer shall form borders between footpath and the Lawns. The shrubs shall be planted at spacing not more than 25 cms.

27.01.03 Planting Shrubs

Shrubs with coloured leaves like Crotons, Acalyphia, Oleander and Bougainvillea, Hibiscus etc. which are perennial shall be planted in clusters or over a large area at locations and in the manner as per approved layout. These shrubs shall be planted at spacing of not more than 25 cms.

27.02.00 INSTALLATION OF WATERING SYSTEM

or shall prepare and submit watering System for the Plants. Drip Irrigation and Spray System consisting of complete G I pipe with all necessary bends, Tees, Elbows etc., valves, stop cocks, Spray nozzles, sufficient lengths of Flexible PVC pipes to reach all area of Landscaping shall be included in the watering system. Only after approval of the Engineer, the Contractor shall commence the work. The engineer, however, reserves the right to modify the layout system if he deems necessary although he earlier approved it.



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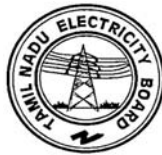
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Section – C4

ARCHITECTURAL REQUIREMENTS

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1.0 ARCHITECTURE

An Architectural Design Intent Memoranda shall be submitted to the owner, which shall include proposals for the following scheme components: shape, form, color, and basic materials for interior and exterior architecture along with an appropriate landscaping scheme. All schemes shall be supported by an architectural statement explaining the factors considered in the design. A minimum of two schemes shall be provided, from which the Purchaser shall select.

The following architectural components which shall be designed for the conditions at the plant site for the design life of 30 years unless specifically noted otherwise.

1.1.0 Exterior architecture

General design criteria for the exterior architectural systems shall be as follows. Quality plans and detailed specifications for all items to be incorporated in the works, shall be approved by owner.

1.1.1 Walls/Cladding

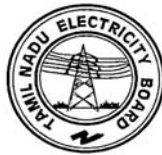
The function of all exterior walls is to provide enclosures for buildings. The exterior enclosure protects the enclosed system and personnel from adverse weather conditions and allows for a controlled interior environment. The cladding of the main plant buildings shall consist of brickwork from ground level. However Turbine generator building and mill building shall have Metallic cladding with colour pre coated galvalume metallic cladding sheets provided above 3 m high brickwork upto roof level. All brick works shall be provided with plastering on both faces and internal and external painting.

1.1.2 Brickwork

The exterior brickwork walls shall consist of load bearing and non-load bearing type construction. Exterior surfaces shall be treated with approved chemical waterproofing or cement plaster. For walls heights exceeding 3.0 m required reinforcement shall be provided to meet the applicable building codes and standards. Bricks of minimum 75 kg/cm² crushing strength shall be provided. Brick work shall be carried out in cement sand mortar 1:4 conforming to IS-1077 or higher cement content. Cement sand mortar shall conform to IS-2250. All brick work in ground floor shall be laid on 40 mm thick damp proof course as per technical specification.

1.1.3 Plastering

All exterior and interior brick work walls shall be provided with plaster on both faces. 12 mm & 20 mm thick plaster shall be provided on the even and rough faces respectively. Minimum cement sand mix of 1:4 shall be used for plaster. Plastering shall conform to IS-1661. Ceiling plaster shall be 6 mm thick with cement sand mix of 1:3.



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1.1.4 Metal wall cladding

Double skin insulated cladding made of 0.5 mm thick silicon polyester colour pre-coated galvalume high tensile steel sheets shall be provided for wall cladding above 3m height upto roof level for TG building and Mill building. The outer and inner skin shall be of profile sheet of depth 28 mm. Cold rolled steel of 550 Mpa yield stress conforming to ASTM A 446 grade E with hot-dip metallic coating of Al-Zn alloy shall be used as substrate. Metallic coating thickness shall be minimum 150 gms/m² total. The surface shall be colour-coated by oven-baked paint system applied over substrate.

The insulation shall be of resin bonded mineral wool of density 48 kg/m³ and thickness 50 mm minimum.

1.2 **Insulation**

Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been determined as generating excessive noise. This sound insulation shall be provided in interior concrete block, sound block, or insulated metal wall panel liners as appropriate. The liner panels shall be as described above, except they shall include perforations and insulation enclosed in plastic bags. The overall Noise Reduction Coefficient shall be 0.80 or better.

1.3 **Windows/Ventilators**

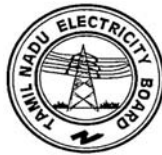
Window and ventilator frames shall be made of extruded aluminum, steel, or other tried and proven material which is resistant to the corrosive environment. Frames shall have a minimum depth of 38 mm and a minimum thickness of 3 mm. Ventilation sections shall be compatible with the frames providing a weather-tight seal. All steel, windows and ventilators shall conform to IS-1361.

All aluminium doors, windows shall be made of extruded aluminium sections of heavy gauge, minimum 3 mm thickness of 'INDAL' or equivalent make.

Glazing of windows shall be done with 5.5 mm thick float glass of best quality for windows located in ground floor and at accessible floors.

Glazing of windows and ventilators located at higher elevations where frequent replacement is not feasible, shall be done with 6 mm thick wired glass conforming to IS-5437.

All windows shall be glazed and fully flashed and sealed for weather-tightness. The entire building enclosure shall be completely weather-tight and air tight. All window hardware shall be substantially made, smoothly finished, accurately fitted, and smooth in operation.



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Windows shall close tightly without binding. Operators shall operate freely and smoothly, adjusted to close tolerances for positive closing of windows with a minimum of play in operator linkages.

All ground floor windows shall be lockable and shall be provided with security grills.

1.4 Louvers

Ventilation openings shall be provided with drainable formed gutter type storm-proof blade louvers complete with bird screens. Operating damper blades shall be provided behind the fixed louvers to allow closing of the openings. On long expanses of louvers, a continuous blade concealed support system shall be provided. Louvers shall be fabricated from extruded aluminum, steel, or other tried and proven material which is resistant to the corrosive environment and shall be provided with a poly-vinylidene fluoride finish.

1.5 Personnel doors

Personnel doors shall be the hollow metal type, flush, 45 mm thick, insulated, with formed hollow metal frames. The doors shall be constructed from 1.3 mm steel sheets with an internally reinforced, insulated core. Frames shall be constructed of 1.6 mm steel, with all joints mitered, welded, and ground smooth. Both doors and frames shall be factory galvanized, primed and field painted. In areas of the plant where excessive negative pressure hinders normal door operation, special balanced door hardware shall be provided.

All steel doors and frames shall conform to IS-1038 & IS-4351.

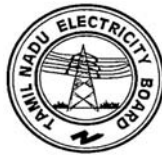
All aluminium doors shall be heavy gauge minimum 3 mm thickness of best quality and workmanship of 'INDAL' make or equivalent.

Glazing of fully glazed doors and partitions shall be done with 5.5 mm thick float glass of best quality.

Doors shall have a glazed vision panel when required by door function. Glazing shall consist of tempered safety glass or wired glass.

Doors located on the ground floor of buildings shall swing out. Doors at other levels shall swing in or as required to meet egress requirements. Heavy-duty hardware shall be used. All outside doors shall be provided with door closers. Locks shall be provided on interior and exterior doors as required by the Owner.

Fire doors shall conform to hollow metal door requirements and shall be provided with fillers adequate to meet the required fire rating. The door, frame, and hardware shall bear a certification label for the class of opening and rating. Doors for fire exits shall be secured with panic bars. Fire doors shall conform to IS-3614 (Part I & II).



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1.6 Equipment access doors

Large access exterior doors shall be vertical lift type rolling shutters, with weather seals and windlocks. Components shall be formed from galvanized steel, factory primed, and field painted. Doors at high traffic areas shall be motor-operated. Doors shall be manually operated where access is infrequent. Rolling shutters shall conform to IS-6248.

1.7 RCC Roofs

RCC roof shall be provided over control rooms and electrical switchgear rooms. RCC roof slab shall be of adequate thickness and laid to proper slope for easy drainage of rain water. Rain water pipes shall be fitted at designated locations. Suitable parapets/handrails shall be provided. For proper access, stairs shall be provided.

The RCC roof slab shall be provided with membrane water proofing treatment with 'Roofosol' two component coating or equivalent. 30 mm thick Polyurethane foam spray insulation with a density of 40 to 45 kg/m³ shall be provided conforming to IS: 13205. The roof surface shall be finished with concrete/brick tiles.

1.8 False floors

Where indicated on the technical drawings, the contractor shall furnish and erect removable modular panels conforming to the following requirements:-

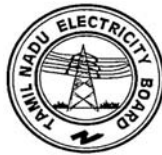
a) Material

Composite panels made of high density 675 kg/m³ waterproof chipboard and aluminium sheets for protection of the interior face. The panel edges shall be slightly chamfered (5°) and protected by an aluminium profile or other conductive material.

Topping shall be made of high-pressure laminate 2 mm thick.

b) Size of the panels

- i) Nominal size shall be 600 x 600 mm.
- ii) Tolerance :
 - 0.2 mm width and length
 - 0.3 mm diagonal
 - 0.2 mm thickness
- iii) Minimum thickness of the panels 40 mm.



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c) **Loading**

- i) 30 kN/m²: The maximum allowed deformation shall be 2 mm under 5 kN point load.
- ii) Minimum height of the free space between sub-floor and raised floor surface for control rooms shall be 1.0 metre.

except if noted otherwise in the execution drawings.

d) **Substructure**

- i) The substructure shall consist of adjustable pedestals and stringers. The pedestals are to be fixed by bolts to the concrete base slab floor. The stringers are bolted to the pedestal so that large cut-outs are possible.
- ii) The whole system shall be constructed in such a way as to allow conductivity of electrostatic charges and shall be connected to the earthing system.
- iii) Penetrations for cables and pipes shall be arranged.
- iv) For allowing an elastic connection to abutting walls, a peripheral joint of 3 mm width shall be arranged and sealed with an appropriate neoprene sealant.

2.0 **Interior Architecture**

Interior architectural systems shall conform to the following general design criteria. Fire rated architectural systems shall be provided when required by building or fire codes. All normally occupied areas shall be finished areas.

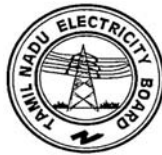
2.1 **Partitions**

Interior walls shall be constructed of masonry, stud framing with gypsum board, metal wall panel, and factory finished assembled demountable type partitions.

Interior walls shall be constructed of concrete block/brick masonry, structurally designed and reinforced where other interior walls shall not provide durability. Plaster finish shall be applied to brick masonry walls followed by paint in approved colour.

2.2 **Windows**

The fixed interior windows shall be framed with formed steel frames, aluminum, or other tried and proven material similar to those of personnel doors, with metal glazing stops. Frames in stud walls shall be the wraparound style. Frames for



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windows between the control room and the turbine area shall consist of fully glazed anodized aluminum storefront system.

Interior glazing shall consist of clear, polished plate, float, or tempered safety glass. Borrowed light fixed glass panels shall be used at corridor/interior work spaces.

2.3 Personnel doors

Wood doors used in finished office areas shall be 45 mm thick full flush, solid core, veneer faced. All wood doors shall be morticed and reinforced at the factory.

Interior doors shall have a glazed vision panel as required. Glazing for the vision panel shall be tempered safety glass or wired glass.

Standard-duty hardware shall be used. Doors shall be provided with approved fittings, such as hinges, mortice, locks of approved make, oxidized lower bolts & handles, door stops, and hydraulic door closers.

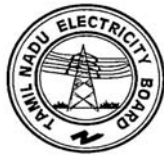
Where fire doors are required, the door, frame, and hardware shall bear a certification label for the class of opening and rating.

2.4 Ceilings

False ceiling shall be provided for all air-conditioned areas and other areas where required from functional requirement.

Ceilings in unfinished areas shall leave the overhead structural frame exposed. The exposed structure shall be painted in unfinished areas. Sound control shall be provided.

Ceilings in finished areas shall generally consist of a suspended, exposed grid, lay-in acoustical type. The ceiling shall not sag when exposed to high local humidity. False ceiling wherever envisaged shall be of aluminium alloy. Scope of work for false ceiling comprises of the supply and installation of TRAC 84C or equivalent approved by the Engineer-in-Charge, ceiling system comprising of 84 mm wide and 12.5 mm deep panels, roll-formed out of 0.5 mm thick aluminium Alloy AA 3005 – 131 mm wide strip. The panel shall be coil coated stove enamelled with 20 micron DFT and of approved standard shades and colours. The panel shall be fixed on to roll-formed panel carriers of size 32 mm wide and 39 mm deep out of 0.60 mm thick black coated GI strip with cutouts to hold panels in a module of 100 mm at maximum 1.6 metre centre to centre. Carriers shall be suspended from roof/truss by 4 mm diameter galvanized steel wire rod hangers with special height adjustment springs out of galvanized spring steel at maximum 1.3 metre centre to centre. Hangers shall be fixed to roof by "J" hooks and nylon inserts or to truss members by regular industrial grade GI wire. The panel length shall be maximum five (5) metre.



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2.5 Grade Floor

Reinforced concrete grade floor shall be provided at ground level in the power plant area comprising of the area from transformer yard, to Boiler area upto chimney. The grade floor shall be in grade M20 concrete of minimum thickness of 200 mm, laid over PCC and compacted crushed stone base of 230 mm thickness. Grade slab shall be provided with reinforcement both ways, top and bottom with minimum 8 mm dia Tor steel at 200 mm c/s (minimum).

2.6 Floor finish

For details refer table-1

2.7 Tiling materials

Tiling materials shall cover the following:-

- i) Tiles
- ii) Ceramic tiles
- iii) Terrazzo materials
- iv) Acid proof tiles

Requirements to be met as follows:-

a) Tiles

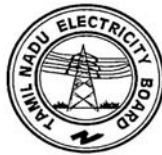
Tiles shall be sharp, straight, parallel, non-crumbling edges, free from soluble salt and other detrimental constituents; free from cracks and blisters; rear and side surfaces capable of bonding effectively for placing, laying and jointing.

All tiles shall be of first class quality. They shall be of uniform size and even surface, free from warps, laminations, serrated edges, chipped corners and other imperfections or flaws affecting their quality, appearance and strength.

b) Ceramic floor and wall tiles

Glazed and/or unglazed ceramic tiles shall comply with the following requirements and properties.

They shall bear the identification mark of the manufacturer on the lower face in either positive or negative embossment. Tiles shall be of approved make.



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They shall be made from fine-grained vitrified sandstone ceramics of the highest quality. The dimensions of the slabs shall be regular and constant, the upper surface plane, smooth and flawless without a trace of fissures or blotches. The sides shall be perfectly straight and the corners perfectly rectified. The shade and hue of the colouring shall be uniform.

They shall give a clear and sound under a hammer stroke. They shall be non-porous, abrasion-resistant (2.5 mm after 3000 hours) flexion and shock resistant (250 g/m²).

Acid (hydrochloric, nitric and sulphuric acid) attacks shall be less than 2.5% of their weight and their water absorbing capacity shall not be in excess of 1.5% of their dry weight.

Colour will be selected by the Engineer.

c) Terrazzo materials

Terrazzo floors or tiles shall be 20 mm thk and shall be of marble chips, granulite or gravel aggregates and be of size, colours and kind as selected by the Engineer.

Non-slip aggregates consisting of aluminium oxide or other approved rust-proof abrasive material not affected by cleaning compounds shall be utilized in all terrazzo work.

Portland cement shall be white or grey as required by the colour scheme selected for the terrazzo materials.

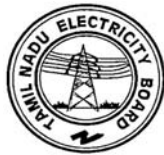
The cement shall conform to the requirement specified under clause "Concrete Works" here above.

d) Acid-proof tiling material

Acid-proof tiles shall be of ceramic unglazed vitreous tiles 20 mm thk as per IS-4457, mortar conforming to IS-4832 (Part I). The tiles shall be scored or dovetailed at the back for improving the bonding properties and to give a good key.

The tiles shall be jointed with synthetic resin cement such as –

- i) polyester resin
- ii) phenolic resin
- iii) furanic resin.



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Execution of tile work

All materials and structural components shall be processed in accordance with manufacturer's instructions.

Prior to the start of his operations under this division, the contractor shall verify that all conditions are suitable for the timely and effective performance of his work. Where unsuitable conditions are found, they shall be reported in writing to the Engineer and under the Engineer's direction immediately corrected.

Work shall be carefully laid out to ensure symmetry about centerlines of the area involved and to obviate the use of less than half pieces of tiles, slabs, etc.

The work shall be executed with the highest degree of precision and according to the drawings and specifications.

Preparation of surface

Before wall surfaces are covered with tiles, flags or mosaic to be set in normal mortar bedding, a sprayed coating of cement mortar shall be applied to the base unless otherwise specified.

Where no adequately even surface is available for work involving thin beddings, special provisions shall be made to compensate for this, e.g., rendering coat, screed.

The concrete surface to which tiles, flags, terrazzo, screed, etc are to be placed, shall be cleaned by wet sandblasting and washed with water under pressure, so as to produce the specified surface condition.

2.8 Wall coverings

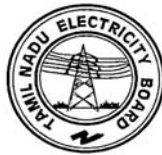
Wall coverings shall be used to enhance the appearance, cleanliness, and wall protection, where appropriate, particularly in lobby and office areas. All wall coverings shall provide a non-absorbing surface.

A glazed surface over concrete block shall be used in locker and shower areas to maintain a sanitary and easily maintained wall. Vinyl wall coverings or ceramic/granite tiles shall be applied to give a finished appearance in entrance lobbies and office areas.

Where specific wall coverings are not desired for the above applications, all finished area walls shall be painted.

2.9 Sanitary facilities

Toilet and shower facilities shall be provided for personnel in finished areas of all major buildings and in other areas as determined by project requirements.



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Sanitary facilities fixture types shall be selected by the Purchaser to provide a balance of local and Western fixtures. Towel and waste receptacles shall be recessed to the extent possible.

Septic tank with soak away shall be provided for all toilets.

Janitor closets and cleaning material storage areas shall be provided in finished areas of all major buildings.

3.0 **Water supply, sanitation and plumbing**

Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank conforming to IS:12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.

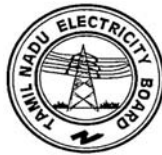
Galvanised MS pipe of medium class conforming to IS:1239 shall be used for internal piping works for potable water supply.

Sand C.I. pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.

Minimum one toilet block with all the facilities shall be provided on each floor of main plant building and service building. Separate toilets for ladies shall be provided wherever required. Attached toilets shall be provided for all senior executive rooms and conference rooms. One toilet shall be provided in the boiler area. All other buildings where toilet is specified shall have one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated below. IS:1172 shall be followed for working out the basic requirements for Water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.

Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass(fancy type).

- i. WC (Indian type) Orissa pattern (580x440mm) as per IS:2556 (Part-3) and 1 no. bibcock with all fittings including flushing arrangement of appropriate capacity and type-1 no.
- ii. WC western type 390 mm high as per IS:2556 (part 2) with toilet paper roll holder and bibcock and all fittings including, flushing system of appropriate capacity and type - 1 no.
- iii. Urinal with all fittings with photo voltaic control flushing system as per IS:2556 (Part-6, Sec.1) - 2 nos. (minimum).



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- iv. Wash basin (oval shape) with all fittings as per IS:2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone - 2 nos.
- v. Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings.
- vi. Stainless steel towel rail (600 x 20mm) - 2 nos.
- vii. Stainless steel liquid soap holder cum dispenser - 2 nos.
- viii. Provision for installation of water cooler.
- ix. Provision of ventilation shaft.

Attached toilets provided for senior executive rooms and conference rooms shall have 1 WC, 1 urinal, 1 washbasin, 1 mirror, 1 no. towel rail, 1 liquid soap holder cum dispenser. WC shall be of western type 390 mm high as per IS:2556(Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type. All toilets shall have atleast 1 no. of exhaust fan. Final no. of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions in the toilet.

An eye & face fountain (combined unit with receptacle) 'conforming to IS:10592 shall be provided in battery room, D.M plant and Chlorination plant.

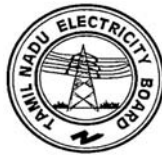
Unless specified all fittings and fixtures in the toilets shall follow technical specification.

Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 12 mm thick polished granite stone.

Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556(Part-5) in laboratories and in Battery room.

In Main Turbine generator building, Service building and Administrative building at least one toilet block shall be provided for ladies.

Other buildings which are not specifically mentioned if found necessary shall be provided with adequate toilet facilities in accordance with NBC (National Building Code (latest)). Final requirement shall be as indicated by the owner.



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Plumbing Design Criteria

The plumbing shall consist of all the hot and cold water supply distribution piping from the potable water header connection to and including the plumbing fixtures. The plumbing fixtures shall include water heaters, lavatories, urinals, toilets, etc. The plumbing shall be rigidly anchored to walls and steel with suitable pipe hangers or wall brackets. All plumbing materials and fixtures shall be of the best quality and make conforming to relevant IS codes and shall be as approved by Owner.

The plumbing shall be sufficient to supply the quantity of water required by the plumbing fixtures. All plumbing work shall correspond to IS-2065 and IS-1172.

The design, layout, construction etc of drains for waste-water, surface water and sewage together with connections, manholes, inspection chambers etc., used within the building and from the building to the septic tank or treatment works shall conform to IS-1742.

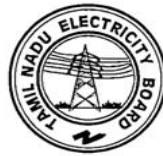
Sanitary & Plumbing Fittings

All sanitary fittings and plumbing fixtures shall be of the best quality and make, and shall be subject to Owner's approval. All water supply fittings in toilets, kitchen etc viz., Bib cocks, pillar cocks, P-traps, towel rail, shower rose, gratings etc., shall be of best quality chromium plated brass of approved make.

All water supply pipes for internal plumbing of buildings shall be of GI pipe of medium class conforming to IS-1239 of approved make. Galvanising of pipes shall conform to IS-4736.

4.0 Finishing Schedule

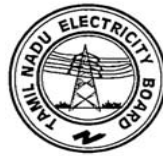
Interior and Exterior Finishes shall be as given in Tables 1 & 2 respectively and general requirements are given in Table-3.



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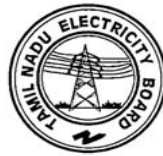
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
1.	Operating / Maintenance areas of workshop, pump houses, compressor house, DG set, Air washer building, AC Equipt. Room, Air handling room, mill & bunker building, Transfer points.	RCC with Metallic hardener topping	Oil bound distemper over plaster of paris	Oil bound distemper
2.	General storage areas	-do-	Oil bound distemper	Oil bound distemper
3.	Cable Vault / cable spreader	-do-	Oil bound distemper	Oil bound distemper
4.	Boiler area paving a) Equipment / vehicle movement area b) Balance area	RCC RCC	-	-
5.	Main Plant Building a) Ground Floor (i) Railway track area unloading bay	RCC with metallic hardener topping	Oil bound distemper	Oil bound distemper



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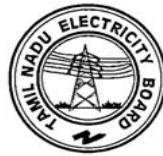
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
	(ii) Balance area including passage	RCC	-do-	-do-
b)	Mezzanine floor (excluding grating area	-do-	-do-	-do-
c)	Deareator floor	RCC with metallic hardener topper	-do-	Metal deck
d)	Operating floor			
	i) Operating area, laydown area, heater area	20mm (Min) thick thandur blue (1 st quality)	Oil bound distemper over plaster of paris (except cladding area)	Oil bound distemper (except metal deck area)
	ii) General circulation and movement areas	7mm thick vitrified ceramic tiles in combination of mirror polished and	-do-	-do-



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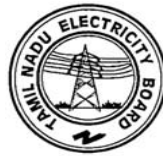
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
		unpolished tiles		
6.	MCC room Switchgear room	7mm thick vitrified ceramic tiles (unpolished) RCC with metallic hardener topping	Oil bound distemper over plaster of Paris -do-	Oil bound distemper -do-
7.	a) Control room area including control room computer room, control equipment room. b) Conference room, senior executive room	False flooring with heavy duty PVC tiles (2 mm thick PVC as per IS:3462) Vitrified tiles over cement concrete flooring	Ceramic tile as approved. i) Acrylic emulsion paint over plaster of paris. ii) Glazed partition with colour anodized Aluminium frame work.	Luxlon false ceiling as approved -do- -do-



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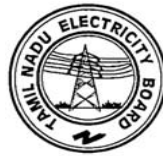
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
	c) Record room	20mm thick Thandur blue stone (first quality)	Oil bound distemper over plaster of Paris	Mineral fibre board
	d) Locker room	20mm thick Thandur blue stone (first quality)	Oil bound distemper over plaster of Paris	
8.	Toilet area	i) 7mm thick dust pressed ceramic tiles ii) 20mm thick Polished granite in one piece for wash basin platform.	Coloured 5mm (min) thick ceramic tiles upto 2.1m with border tiles wherever required and oil bound distemper for balance height.	Oil bound distemper
9.	Pantry Area & Canteen	i) 20mm thick thandur blue stone (first quality) ii) 20mm thick	Coloured 5mm (min.) ceramic tiles upto 1.2m and oil bound distemper for balance height.	Oil bound distemper



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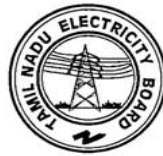
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
		polished granite stone for platform		
10.	Office Room, Staff Room	7mm thick unpolished vitrified ceramic tiles.	Acrylic emulsion paint	Mineral fibre board with MS coated frame works.
11.	SWAS room	7mm thick mirror polished vitrified ceramic tiles	Acrylic emulsion paint	Mineral fibre board with MS coated frame works.
12.	Laboratory area	7mm thick dust pressed ceramic tiles	Acrylic emulsion paint	White wash
13.	RCC Stair case	20mm thick thandur blue stone (first quality) for riser & tread	Coloured 5mm thick (min) ceramic tile matt finish upto 1.2m ht & Resin bonded granular texture finish for balance height.	Oil bond distemper over plaster of paris on underside of staircase.



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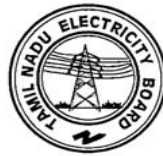
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
14.	Entrance lobbies and lift areas	20mm thick polished granite stone	i) Resin bonded granular textured finish. ii) 20mm thick polished granite on lift facia.	0.5 mm thick coil coated, Lineal Aluminium false ceiling.
15.	Passages and general circulation areas	20mm thick thandur blue stone (first quality) with border	Oil bond distemper over plaster of paris	Mineral fibre board false ceiling and white wash for non false ceiling areas.
16.	Battery room			
	i) For lead acid batteries	20mm thick acid resistant tiles over bitumen primer.	20mm thick acid resistant tiles over bitumen primer upto 1.2 m height and chemical resistant epoxy paint for balance height	Chemical resistant epoxy paint.
	ii) For Ni-Cd batteries	7mm thick dust	Oil Bound Distemper	White wash.



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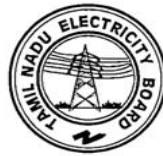
TABLE - 1 INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
		pressed ceramic tiles.	(OBD) Over Plaster Of Paris (POP)	
17.	Oil canal, oil room, oil purification tank and other areas where oil spillage is likely to occur.	Oil resistant paint (epoxy based amine cured) 150 micron over primer over CC flooring	Oil resistant paint upto 1.2m height and OBD for balance height.	Oil bound distemper except oil canal area.
18.	Re-generation and other than areas requiring acid / alkali resistant treatment.	Cement concrete flooring with metallic hardener topping	Oil Bound Distemper.	Oil bound distemper.
19.	Covered parking area	Interlocking cement concrete blocks	Oil bound distemper	Oil bound distemper
20.	Pathways including equipment installation area on top of roof	22mm thick concrete chequered tiles.	-	-



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TABLE - 1				
INTERIOR FINISHING SCHEDULE				
SL. NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER.
	Note a. All wall and roof areas above false ceiling shall be plastered and white washed. b. The colour and pattern of finish shall be as per approved details. c. All material shall be of reputed and established brand approved by Engineer. d. Wherever alternative materials are specified, the final selection rests with Engineer. e. This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities. f. All the finishing materials shall be applied / provided as per manufacturer specification and guidelines under the supervision & guidelines of manufacturer. g. Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Engineer.			

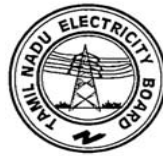


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TABLE – 2
EXTERIOR FINISHING SCHEDULE

SL.NO.	DESCRIPTION OF AREA	WALLS AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Turbine generator building and mill building	i) Initial height of 3m (nominal) permanent finish using bricks cladding in cement mortar, finished with plastering, smooth finish and two coats of water proof cement based paint as per IS:5410. ii) Approved color / color combination of color coated metal cladding for balance height.	Two coats of water proof cement based paint as per IS:5410. Approved color / color combination of color coated metal cladding.
2.	Building with concrete frame work, fire walls, etc.	Two coats of water proof cement based paint as per IS:5410	Two coats of water proof cement based paint as per IS:5410.
3.	Steel structures, trestles etc.	Two coats of synthetic enamel paints of approved shade conforming to IS:2932 over tow coats of red oxide zinc chromate primer conforming to IS:2074. (25 microns per dry film for primer and final coats)	

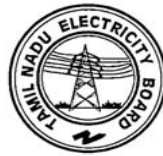


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TABLE – 2
EXTERIOR FINISHING SCHEDULE

SL.NO.	DESCRIPTION OF AREA	WALLS AND PROJECTIONS	SOFFIT OF PROJECTIONS
4	Chimney	Painting for aviation requirements refer technical specification. The balance portion shall receive two coats of water proof cement based paint as per IS:5410	

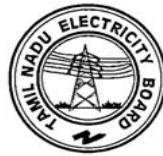


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TABLE – 2
EXTERIOR FINISHING SCHEDULE

SL.NO.	DESCRIPTION OF AREA	WALLS AND PROJECTIONS	SOFFIT OF PROJECTIONS
5	Cooling tower a) Basin floor. b) Internal and external basin wall. c) Diagonal columns d) Fill support columns and beams e) Hot water duct (Internal and external surfaces) f) Cold water channel (Internal and external surfaces) g) Drain chamber (Internal and external surfaces). f) Shell (atleast 2 metres at the top and bottom and for at least 1 metre on the outside of the shell at top and bottom)	one coat of primer conforming to IS:3384 and two coats of bituminous paint conforming to IS:3384 and a dry film thickness of 75 microns per coat	

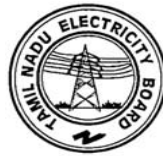


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TABLE – 2
EXTERIOR FINISHING SCHEDULE

SL.NO.	DESCRIPTION OF AREA	WALLS AND PROJECTIONS	SOFFIT OF PROJECTIONS
	Note: colour.	1. The colour and pattern of finish shall be as finalized by engineer. 2. All materials shall be of reputed and established brand approved by Engineer. 3. All the finishing work shall be carried out as per manufacturer specifications and of approved	

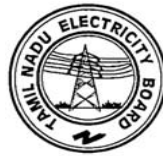


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TABLE – 3
GENERAL INTERNAL DETAILS

SL.NO.	Items	Descriptions	Specific locations
1.	External brickwork	230 mm thick minimum up to ceiling as per specification	For all buildings except in metal clad areas. However minimum thickness shall be 230mm.
2.	Firewall	350 mm thick brick wall or 230 thick RCC wall up to required height as per specification.	Normally around transformer area
3.	Internal brickwork	115 mm thick minimum up to ceiling as per specification to be reinforced and checked for stability.	All buildings except where sound insulation and fire safety requirements to be followed.
4	Parapet walls	1. 230 mm thick minimum 750mm height as per specification 2. 230 mm thick minimum 1000mm height as per specification	Inaccessible roofs. Accessible roofs.
5.	Wooden doors	Teak wood door as per specification	All doors in office areas except entrance of Administrative building, service building and canteen building

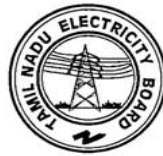


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TABLE – 3
GENERAL INTERNAL DETAILS

SL.NO.	Items	Descriptions	Specific locations
6.	Aluminium doors	Electro color coated anodized frame work with glazing (5.5mm transparent sheet glass)	1. Single leaf/ double leaf with double swing, at entrance lobby of all buildings and in office areas of plant and Non-plant buildings as per owners requirements. 2. Double doors, Single leaf/ double leaf with double swing between air conditioned and Non air-conditioned areas of plant and Non-plant buildings as per owners requirements.
7.	Pressed steel doors	As per specification	In all areas except toilet, office areas, battery room, administrative, service and canteen building.
8.	Rolling shutters	Mechanically or electrically operated and sized as per handling requirements.	Entrance of all plant buildings unless specifically mentioned elsewhere

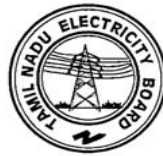


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TABLE – 3
GENERAL INTERNAL DETAILS

SL.NO.	Items	Descriptions	Specific locations
9.	Fire proof doors	Minimum fire rating of two hours and conforming to IS:3614 (Part I & II) shall meet TAC requirements	At exit and entry points of fire prone areas identified in layout.
10.	PVC doors	As per specification	Toilet and battery room
11.	Windows/ventilators	1. Aluminium windows/ventilators as per specification with 6 mm wired glass conforming to IS:5437 2. Aluminium windows as per specification with 5 mm thick frosted glass. 3. Aluminium windows double glazed as per specification with 2 nos. of 6mm thick clear toughened safety glass conforming to IS:2553 separated by 12mm thick thermal insulation.	1. Turbine generator building, pump house, compressor house, DG building, transfer points, workshop buildings, fire escape staircase and fire prone buildings/areas. 2. Toilet areas. 3. In air-conditioned buildings / areas as per requirements.
12.	Louvers	Aluminium louvers	As per functional requirements

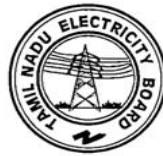


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Specification No:SE/E/T&H(P)/No.175 / 2007-2008
Volume-V: Technical Specification-Civil

TABLE – 3
GENERAL INTERNAL DETAILS

SL.NO.	Items	Descriptions	Specific locations
13.	Handrail posts	1. Stainless steel rail and posts with 32 NB pipe. 2. MS rail and posts with 32 NB pipe as per specification	Turbine generator building operating building. The top rail shall be polished teak wood for stairs in administrative building, canteen building and service building and at places visited by VIP's to be identified by owner. In all areas not metioned elsewhere but specifically required for safety measures.
14.	Toilets	As per specification and owners requirements	At places decided by owner.
15.	Over head water tanks	Polyethylene water storage tanks conforming to IS:12701 complete with all fittings.	All buildings, size shall be decided based on number of users as per owner requirements
16.	Rainwater down comers	150mm dia. HDPE Pipe conforming to IS: 4984 as per specification.	From Roof of all building upto plinth protection
17	Roof access.	Cage ladders	Atleast one for all buildings from ground floor to roof.

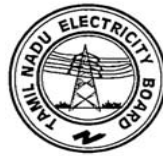


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TABLE – 3
GENERAL INTERNAL DETAILS

SL.NO.	Items	Descriptions	Specific locations
18.	Sunshades	1200mm wide upto 3m high entrance openings and 1500mm wide upto 6m high. 600mm wide minimum. - Decorative sunshades of large span	- Entrance doors/rolling shutter for all plant and Non-plant buildings except administrative and service buildings - For all openable windows. - Administrative and service buildings as per owners requirements
19.	Protection around openings	200mm high RCC kerbs of 200mm thick shall be provided around openings with 150 mm(high) x 8mm (thick) toe guards with handrails and posts (removable / fixed type). 200mm high RCC kerbs of 200mm thick shall be provided around openings and covered with chequered plate / gratings.	Large openings of size greater than 300mmx300mm. Smaller openings of size lesser than 300mmx300mm.

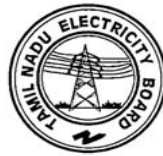


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TABLE – 3
GENERAL INTERNAL DETAILS

SL.NO.	Items	Descriptions	Specific locations
20.	Edge protections	ISA 50x50x6(minimum) angle with lugs	For all concrete edges around openings, trenches, expansion joints, supporting gratings, chequered plates, etc,
21.	Damp proof course	1:1.5:3 concrete with minimum 2% water proofing compound	All buildings ground floor
22.	Punning	2mm thick plaster of paris punning over plaster	In all office blocks, control room , administrative building, service building and other air-conditioned areas
23	Staircase	1. 1000mm wide (min.), 250mm tread and 180mm risers (max) 2. 1500mm wide(min.) 250mm tread and 180mm risers (max)	1. In all plant buildings 2. Administrative building, service building and fire escape areas
24.	Under deck insulation	Under deck insulation with polystyrene blocks	On ceilings in air-conditioned areas, under building roofs



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SL.NO.	Items	Descriptions	Specific locations
25	Drains	1. RCC Storm water drains with 25mm thick screed concrete (1:1.5:3 mix) upto 250 mm high (min.) from drain invert. 2. RCC drains with lining as per effluent requirements.	1. For plant drainage 2. For effluent drains
26	Roads	1. Concrete roads with shoulders as per specification 2. Rigid pavements with shoulders as per specification	1. Entire plant except bulldozer movement area 2. In bulldozer movement area
27	Paving around buildings	1m wide as per specification	For all buildings
28	Water stops	230 wide PVC water stops as per specification	At all construction joints and
	Rungs	20 mm MS rungs with epoxy coated paint	Pits and sumps
29	Plumbing	GI pipes as per specification and design requirements	For toilets and drinking water areas

TENDER SPECIFICATION

BHEL PSSR SCT 1348

**GENERAL CIVIL WORKS FOR MAIN PLANT AND
AUXILLARY PLANT BUILDINGS**

FOR

2 X 600 MW TPP

FOR

TAMIL NADU ELECTRICITY BOARD

ATHIPATTU, TAMIL NADU

VOLUME – II BOOK 2

**TECHNICAL SPECIFICATION
BOOK NO ...**



**BHARAT HEAVY ELECTRICALS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
POWER SECTOR – SOUTHERN REGION 690,ANNA
SALAI, NANDANAM, CHENNAI – 600 035**

BHEL: PSSR: SCT: 1348: VOL II: BOOK 2

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AND BACKFILLING**

SPECIFICATION NO.

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SECTION - D (PART - I)

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VOLUME: II B

**SECTION - D
(PART I)**

SUB-SECTION – D I

EARTHWORK IN EXCAVATION AND BACKFILLING



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**STANDARD TECHNICAL SPECIFICATION
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.00.00 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

1.01.00 Work To Be Provided By the Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

- a) Supplying and providing all labour, supervision services including as required under statutory labour regulations, materials, scaffolding, equipments, tools and plants, transportation etc required for the work.
- b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.
- c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.
- d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

1.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.00.00 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.



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IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.02.00 Materials

2.02.01 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.02.02 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, the following classification are to be followed.

a) Soil

It include all type of soil including laterite and moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under clause 2.02.02 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.



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c) Hard Rock

It include the rocks which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

2.02.03 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.03.00 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments



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used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

3.00.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms and compaction etc within 15 days of award of the contract to the engineer for approval.

3.01.00 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.02.00 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the



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engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.03.00 Excavation for Foundations and Trenches

3.03.01 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost



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of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.03.02 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.03.03 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder



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from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.03.04

Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective



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blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.
- * not to touch the magazine shoes on ground outside the clean floor.
- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in



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the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the



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holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.



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f) Restrictions in Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.03.05 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

- a) By using it straightway for backfilling.
- b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.
- c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.
- d) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.03.06 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.03.07 Protection

The contractor shall notify the engineer as soon as the excavation is expected



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to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.03.08 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.03.09 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

a) Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on



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the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

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

b) Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.03.10 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.04.00 Backfilling

3.04.01 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.



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3.04.02 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.04.03 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.04.04 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.04.05 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be



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dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.05.00 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.06.00 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.02.00 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be



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as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.02.00 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.



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c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

6.00.00 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.01.00 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.02.00 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.



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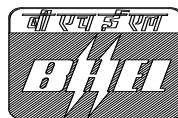
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SUB-SECTION - D II

CEMENT CONCRETE (PLAIN & REINFORCED)



Bharat Heavy Electricals Limited
Project Engineering Management



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SUB-SECTION – D II

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for

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installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- g) Design and submit for approval concrete mix designs required to be adopted on the job.
- h) Furnish samples and submit for approval results of tests of various properties of the following:
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer**2.03.01 With Tender**

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be



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adopted.

- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02

After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other*waterproofing materials.
- vi) Joint filling compounds.

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vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment
As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00**Conformity with Design**

The Contractor will prepare checklists in approved Proforma, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all

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necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used**2.05.01 General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

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2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture

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The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTM C-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars above 10 mm dia. shall be of tested quality.

2.06.00 Storage of Materials**2.06.01 General**

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be

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kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture:	Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.
	For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
b) Aggregate:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c) Water:	Impurities tests.
d) Cement:	Tests to satisfy relevant IS Specifications.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances,

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ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

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3.00.00	INSTALLATION All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.	
3.01.00	Washing and Screening of Aggregates Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.	
3.02.00	Admixture All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.	
3.03.00	Grades of Concrete Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.	
3.04.00	Proportioning and Works Control	
3.04.01	General “Design Mix Concrete” and “Nominal Mix Design” is defined as follows for use in this specification: - Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete". - Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal	



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Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS: 456. All other relevant clauses of IS: 456 shall also apply.

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3.06.00**Minimum Cement Content**

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00**Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on:-

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01**Strength Requirement**

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

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3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V
LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

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Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Lean concrete	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

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3.09.01

Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills):

The temperature of fresh concrete shall not exceed 25°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 25°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 25°C.

3.09.02

Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00**Mixing of Concrete**

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

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When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with

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the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected

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concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints**3.13.01 Construction Joints**

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the



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beam framing into it.

- b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02

Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive

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vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- 9) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.



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- k) Polymer modified patching and adhesive repair & mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

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3.15.00**Protection and Curing of concrete**

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected 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. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost

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thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under

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very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Drawings. Welding of cold twisted High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type,

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shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work**3.20.01 General**

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be

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strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02**Cleaning and Treatment of Forms**

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

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3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

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3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

- For -
- a) Sectional dimension - ± 5 mm
 - b) Plumb - 1 in 1000 of height
 - c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

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- c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

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Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints**3.23.01 General**

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board**a) Bitumen Board**

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

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3.23.03**Joint sealing strips**

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm

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width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

- i) Plain
- ii) Central bulb
- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C

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Ultimate Elongation : Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity : 1.3 to 1.35

Shore Hardness : 60A to SOA

Tensile Strength : 10 - 15 N/Sq.mm

Maximum Safe Continuous
Temperature : 70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

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3.24.00**Grouting under Machinery or Structural Steel Bases**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00**Precast Concrete**

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they

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shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure**3.26.01 General**

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the

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joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03**Waterproofing Admixtures**

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or



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as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.

- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

- a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

- b) External Treatment

Two layers of (1 : 4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.



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The Contractor shall execute this work in direct collaboration with one of the well known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.
- ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to

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vii) above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface
3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING**4.01.00 General**

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

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4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture**4.05.01 Air Entraining Agents**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded

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	items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.				
5.00.00	ACCEPTANCE CRITERIA				
5.01.00	Standard Deviation				
	Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.				
5.02.00	Acceptance Criteria				
	The strength requirements and acceptance criteria shall conform to IS: 456.				
5.03.00	Inspection and Core Tests				
	Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.				
5.04.00	Load Test				
	Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.				
	If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.				
	The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.				
	If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.				
6.00.00	RATES AND MEASUREMENTS				
6.01.00	Cast-in-situ Concrete				
6.01.01	Rates				
	a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall also include the cost of using curing compound, whenever used.				

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- b) The unit rates shall include for all working conditions including in or under water, liquid, mud, in or under foul positions, under tides, and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Facilities and arrangement are to be provided by the agency for conducting ultrasonic pulse velocity tests or other relevant tests to ascertain grade and quality, etc. of the concrete, if required. However, for conducting UPV test and any other additional Non-destructive test to ascertain the quality of the concrete specifically required shall be paid separately. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.
- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of making additional trial mixes, using the super-plasticizer and mixing in concrete etc.

6.01.02**Measurements**

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres.
- b) No deductions shall be made for the following:
 - i) Opening upto 0.1 sq.m.
 - ii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iii) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

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- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 25⁰C.

6.02.00 Reinforcement**6.02.01 Rates**

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.
- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.
- c) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- d) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

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- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging**6.03.01 Rates**

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.
- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.
- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- c) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or

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equal to 0.1 sq.m. in each case.

- d) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts**6.04.01 Rates**

- a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.
- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts.

6.04.02 Measurements

- a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.
- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.



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- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Grouting

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

- a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

- b) Water Stops

The measurement for water stops shall be in running metres of actual

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length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete**6.07.01 Rates**

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

6.07.02 Measurements

- Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be on the same basis as that employed for construction work.
- Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

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This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

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IS: 432 -		Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement			
IS: 455 -		Indian Standard Specification for Slag Cement			
IS: 456 -		Indian Standard Code of Practice for Plain and Reinforced Concrete			
IS: 457 -		Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures			
IS: 516 -		Indian Standard Specification for Methods of Test for Strength of Concrete			
IS: 702 -		Indian Standard specification for industrial bitumen.			
IS: 1199 -		Indian Standard Specification for Methods of Sampling and Analysis of Concrete			
IS: 1322 -		Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing			
IS: 1489 -		Indian Standard Specification for Portland Pozzolona Cement			
IS: 1566 -		Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.			
IS: 1609 -		Code of Practice for Laying Damp-proof Treatment using Bitumen Felts			
IS: 1786 -		Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.			
IS: 1791 -		Indian Standard Specification for Batch Type Concrete Mixers.			
IS: 1838 -		Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).			
IS: 2185 -		Indian Standard Specification for Hollow Cement Concrete Blocks			
IS: 2210 -		Indian Standard Specification for Design of Reinforced			

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Concrete shell Structures and Folded Plates

- IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
- IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
- IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type
- IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators
- IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables
- IS: 2571 - Code of practice for laying in-situ cement concrete floors.
- IS: 2645 - Integral cement water proofing compound
- IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
- IS: 2750 - Indian Standard Specification for steel scaffoldings.
- IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
- IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
- IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
- IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
- IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses
- IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
- IS: 3414 - Code of practice for design and installation of joints in buildings.

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	IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete IS: 3696 - Safety Code for Scaffolding and Ladders IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete IS: 4014 - Code of practice for steel tubular scaffolding. IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant IS: 4926 - Indian Standard Specification for Ready Mixed Concrete IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys. IS: 5256 - Code of practice for sealing joints in concrete lining on canals.	

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IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials IS: 5513 - Indian Standard Specification for vacate Apparatus. IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus. IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works. IS: 5624 - Indian Standard Specification for foundation bolts. IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks. IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders. IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers. IS: 5892 - Indian Standard Specification for transit mixer and agitators. IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use IS: 6909 - Indian Standard Specification for Super sulphated Cement IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators. IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures. IS: 7242 - Indian Standard Specification for Concrete Spreaders. IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete. IS: 7251 - Indian Standard Specification for Concrete Finishers. IS: 7293 - Safety code for working with construction machinery. IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus. IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.					

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- IS: 7969 - Safety Code for Storage and Handling of Building Materials.
- IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.
- IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.
- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.
- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.
- IS: 9012 - Recommended method for shortcreting.
- IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.
- IS: 9103 - Indian Standard Specification for Admixtures for Concrete.
- IS: 10262 - Recommended Guidelines for Concrete Mix Design.
- IS: 13311 - Non-destructive testing of concrete.
- SP: 34 - Handbook of concrete, reinforcement and detailing.



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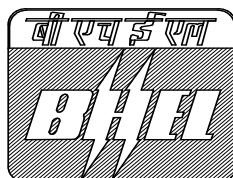
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CARPENTRY AND JOINERY



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CARPENTRY AND JOINERY**1.00.00 SCOPE**

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION**2.00.01 Materials****a) Timber**

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is



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BWP grade phenol formaldehyde synthetic resin conforming to IS: 848.
The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship**2.02.01 General**

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.



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2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA**3.00.01 Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmet, Furniture, etc.**3.03.01 General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

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3.03.03	Pelmets Shall be checked for rigidity of fixing and adequate clearance of fixture.	
3.03.04	Cupboard Shutters Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.	
3.03.05	Drawers Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.	
3.03.06	Loose Furniture When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.	
4.00.00	IS CODES All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. IS: 848 - Synthetic resin adhesives for plywood (Phenolic and Aminoplastic) IS: 1003 - Timber panelled and glazed shutters. IS: 2191 - Wooden flush door shutter (Cellular and hollow core type). IS: 2202 - Wooden flush door shutters (solid core type). IS: 4021 - Timber door, window, and ventilator frames.	
5.00.00	RATES AND MEASUREMENT	
5.01.00	Rates Rates shall include of all activities mentioned in “Schedule of Item” for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges,	



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holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00

Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.



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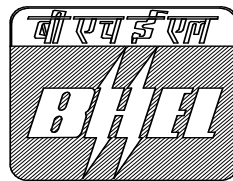
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**ROOF AND UNDERGROUND STRUCTURES WATER
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Project Engineering Management



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**ROOF AND UNDERGROUND WATER PROOFING,
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This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION**2.01.00 GRADING UNDERBED**

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12 mm down stone chips and coarse sand. The aggregate shall be



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mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expanded Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's



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approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:



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a) Normal Treatment - Five courses

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Fiber base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fiber base self-finished felt, type 2, grade 2.



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6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fiber-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.



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8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02

Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.



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b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.



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2.04.03**Waterproofing By Epoxy Resin Based Application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02**Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00**WATER-PROOFING OF UNDERGROUND STRUCTURES**

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- a) 2 layers - for depths up to 5m below ground level
- b) 3 layers - for depths beyond 5m below ground level

2.05.01

Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-



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soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

- i) Primer (For vertical faces only), as per I.S. 3384.
- ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base, bitumen felt type 3 grades 2
- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²

B) Extra Heavy treatment (Three layers of felt)

- i) Primer (for vertical faces only) as per I.S. 3384
- ii) Hot applied bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base bitumen felt type 3 grades 2
- iv) Hot applied bitumen at the rate 1.2 Kg/m²
- v) Hessian base bitumen felt type 3 grades 2



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FOR ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

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vi) Hot applied bitumen at the rate of 1.2 Kg/m²

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00

ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship for 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00

I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the



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latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the “Schedule of Items”.

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.



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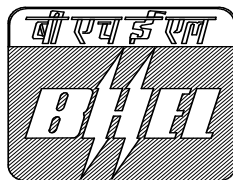
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METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.**1.00.00 SCOPE**

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION**2.01.00 Materials**

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.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified 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. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS:



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1081 or as approved by the Engineer.

2.02.00 Fabrication**2.02.01 Steel Doors, Windows, Ventilators, louvers etc.**

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on 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 as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. 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.

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 surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.



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c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G 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 shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.



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2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or 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. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, 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.

When taking delivery of items supplied by Owner, the Contractor shall satisfy



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himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00

Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper "Lines and levels", and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

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

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0

Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from



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external fire. The construction details of door shall conform to the requirements stipulated in IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA**3.01.00 For fabricated Items**

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) 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.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.
- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures
- h) Provision for hardware and fixtures to be installed at site.
- i) Glazing beads shall be cut with mitered corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- k) Shop coats shall be properly applied.
- l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.



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3.02.00 For installed Items

- a) Installations shall be at correct location, elevation 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 of transoms and mullions, gaskets, weather strips etc. complete.
- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners etc. shall be engage positively. Key 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.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

- a) Names of manufacturers for Doors, windows etc.
- b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

- a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.
- b) He shall submit a programme of work to be done for the approval of the Engineer.
- c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final

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incorporation in the job.					
5.00.00	IS CODES				
All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.					
Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose) - IS: 733					
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose) - IS: 1285					
Steel doors, windows, and ventilators - IS: 1038					
Steel windows for industrial, building - IS: 1361					
Aluminium doors windows, and ventilators - IS: 1948					
Aluminium windows for industrial buildings - IS: 1949					
Steel doorframes - IS: 4351					
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators. - IS: 1081					
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type - IS: 3614					
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification - IS: 7452					
6.00.00	RATES AND MEASUREMENT				
6.01.00	Rates				
Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding,					



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grouting, grinding, making good of the structure for installing the unit etc. complete as per "Schedule of Items".

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00

Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm in net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition shall be from net outer to outer area of frames i.e., frames are part of partition.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.



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ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

i) 100 mm brass butt hinges with screws - 3 Nos.

ii) 150 mm brass tower bolts with screws - 1 No.

iii) 100 mm x 225 mm clear plastic push
Plate with counter sunk brass screws - 1 No.

iv) 30 mm brass ring pull handle with
Plates and screws - 1 No.

v) 150 mm brass coat hook with screws - 1 No.

vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-
closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

i) Concealed hanging arrangement for door leaves.

ii) Concealed two points bolt encasing simultaneously at head and threshold
on inactive leaf, operable from inside.

iii) Heavy duty, cylinder look on active leaf.

iv) Pull handle of approved design on both leaves.

v) Doors stops for both leaves.

vi) Overhead door closure for both leaves.



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ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i) 100 mm butt hinges	- 3 Nos. on each leaf.
ii) 300 mm aluminum tower bolt	- 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.
iii) 200 mm anodized aluminum pull handle	- 1 No. of each leaf.
iv) Door stop of approved design	- 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i) 100 mm butt hinges	- 3 Nos.
ii) 300 mm aluminum tower bolt	- 2 Nos. top & bottom of Inside face
iii) 200mm anodised aluminum Pull handle	- 1 No.
iv) Door stop of approved design	- 1 No.

NOTE: For locks, door closures and threshold, sec "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) 12" peg stays	- 1 No. per leaf



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ANNEXURE-A

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.

ii) Adjustable sliding fabrication
assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the
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hinges Per leaf.

ii) Concealed side arms for
opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.



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ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.

(As per I.S-1948 latest editions)

a) Side Hung Windows

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) 300 mm peg stays - 1 No per leaf
- iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) Adjustable sliding fabrication assemblies - 2 Nos. per leaf
- iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation&(Projecting In)

- i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
- ii) Concealed side arms for opening adjustment - 2 Nos. per leaf
- iii) Spring Catch - 1 No. per leaf



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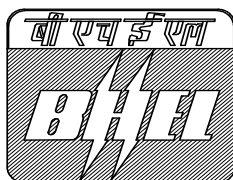
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GLASS AND GLAZING



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GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

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, from approved manufacturer like Hindustan Pilkinton 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.

Materials

- a) Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.
- b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.
- c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.
- d) Obscure glasses shall have a cast surface in one side.
- e) Coloured and figured glass shall be as per approved sample.
- f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.
- g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.



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All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes where six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00**ACCEPTANCE CRITERIA**

- a) All installation 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 underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00**I.S. CODES**

Following are some of the important I.S. Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.



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5.00.00

RATES

Rates of glass and glazing are included in respective items for supply and installation of window, ventilator, and partitions. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.



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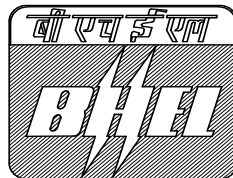
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ROLLING STEEL SHUTTERS AND GRILLS



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ROLLING STEEL SHUTTERS AND GRILLS**1.00.00 SCOPE**

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION**2.01.00 Components**

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods.
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.
- f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.
- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.



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- i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and 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 each 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 in drawing.

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.

- j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.
- k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all



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abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE**3.01.00 Shop Inspection**

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in "Schedule of Items".



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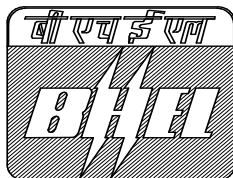
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MISCELLANEOUS METAL**1.00.00 SCOPE**

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION**2.01.00 Fabrication/casting****2.01.01 General**

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

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2.02.00	Erection				
2.02.01	Bracing				
	The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.				
2.02.02	Temporary Bolting-Up				
	As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.				
2.02.03	Turned Bolt				
	For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.				
2.02.04	Welding				
	Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.				
2.02.05	Cutting and Fitting				
	No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.				
2.02.06	Drifting				
	Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.				
	Any error in shop work which prevents the proper assembling and fitting of				



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parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.



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- d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.
- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING**2.03.01 Chain Link Fencing**

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.



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Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02

Barbed Wire Fencing

The barbed wire shall be conform to IS:278 latest edition. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75 ± 12 mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a



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wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00**ACCEPTANCE CRITERIA**

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as follows
 - i) Permissible deviation from, straightness – 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00**IS CODES**

- IS:278 Specification for Galvanised Steel Barbed wire for fencing.
- IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.
- IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
- IS:2721 Specification for Galvanised Steel Chain Link fence fabric.
- IS:2812 Arc welding of Aluminum and Alloy

5.00.00**RATES AND MEASUREMENTS****5.01.0****Rates**

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items. Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement



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concrete), unless any specific item is excluded.

5.02.0

Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



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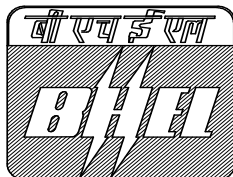
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MASONRY AND ALLIED WORKS**1.00.00 SCOPE**

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS**a) Brick**

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or

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instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

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Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION**3:01.00 Soling****3.01.01 Brick Soling**

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on

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the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry**3.03.01 General**

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs

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upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

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3.03.07	Exposed Stone work Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.
3.03.08	Composite Masonry Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.
3.03.09	Expansion & Separation Joints Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer. Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.
3.03.10	Mouldings, Cornices, Drip Course These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.
3.03.11	Curing Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.
3.03.12	Embedding of fixtures All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.
3.03.13	Encasing of Structural Steel

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This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted 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 brick aggregate shall be well graded, broken from well burnt or slightly overburnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

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

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of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next 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.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00**I.S. CODES**

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

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IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS**5.01.00 Rates**

Unit rate for masonry work shall include the following:

- a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- b) Preparing top sand sides of existing wall for joining old with new work.
- c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.
- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.



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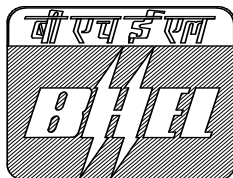
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Bharat Heavy Electricals Limited
Project Engineering Management



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1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

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 rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

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.

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 in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be

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mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

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.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm 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 with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer 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.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. 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 regarding the texture, color and finish.

a) Standard Finish

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

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b) 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 one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) 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 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and

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allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04**Curing**

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00**Pointing to masonry**

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust

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from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not 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 workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

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2.07.00**Stone Facing**

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00**ACCEPTANCE CRITERIA**

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

4.00.00**I.S. CODE**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

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IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.



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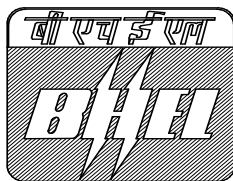
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PAINTING, WHITEWASHING, POLISHING



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PAINTING, WHITE WASHING, POLISHING, ETC.**1.00.00 SCOPE**

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 Installation**2.00.01 Materials**

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, 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 reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.



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a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit 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, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.



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f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02

Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00

Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.



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2.01.02**Wood**

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02**Masonry, Concrete, and Plastered Surface**

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

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03**Metal**

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated 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. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

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2.02.00	Application	
2.02.01	General	
	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 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.	
	Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.	
	Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, 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 paint.	
	All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.	
	No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.	
	All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.	
	All primers and undercoats shall be tinted to approximate the colour of the finishing coats. 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.	
	Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.	
2.02.02	White Washing	
	The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up	



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with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

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 in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. 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. Painting shall be done strictly as per manufacturer's specification.



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2.02.07 Synthetic Enamel Paint

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

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.



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After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for ease of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly dampened with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.



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Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00**I.S. CODE**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348 Specification for French polish

IS: 427 Specification for Distemper, dry colour as required.

IS: 428 Specification for Distemper oil emulsion, colour as required.

IS: 1477 Code of Practice for painting of ferrous metal
(I & II) in buildings.

IS: 2338 Code of Practice for finishing of wood and



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(I & II) wood based materials.

IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.

IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.

IS: 2932 Specification for enamel, exterior type-1.

IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall be unit rates for complete items described in the “Schedule of Items”.

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. unless specified otherwise.



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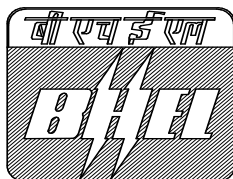
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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

- a) In Situ Finishes
 - i) Integral finish to concrete base
 - ii) Terrazzo finish
 - iii) Granolithic finishes
 - iv) Patent Stone
 - v) Metallic Hardener like “Ironte”/Hardonate Finish
 - vi) Mastic Asphalt finishes
 - vii) Chemical Resistant finish
- a) Tiled Finishes
 - i) Terrazzo tile
 - ii) Chequered tile
 - iii) Glazed tile
 - iv) Tesse rae (Mosaic etc.)
 - v) Chemical Resistant
 - vi) Rubber, Vinyl etc.
 - vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence



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Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be bone dry where adhesives are used for fixing the finishes.



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Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips



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shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled f or horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth



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dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03

Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix



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The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface ‘ of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

d) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding



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If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of



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the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/'Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very 'green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to



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secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.



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The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

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The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of



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the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02

Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed

As per clause 2.02.01 (c).

d) Laying

As per clause 2.02.01 (d).



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e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.



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- d) Laying
Same as clause 2.02.01 (d).

- e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

- a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

- b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

- c) Mix: Underbed
Same as clause 2.02.03 (c)

- d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.



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2.02.05 Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with



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manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap,



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dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed

Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.



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e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

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4.00.00	I.S. CODES All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. IS: 777 : Glazed earthenware tiles IS: 1196 : Code of practice for laying bitumen mastic flooring. IS: 1197 : Code of practice for laying of rubber floors IS: 1237 : Cement concrete flooring tiles IS: 1443 : Code of practice for laying and finishing of cement concrete flooring tiles. IS: 2114 : Code of practice for laying in situ terrazzo floor. IS: 3461 : PVC asbestos floor tiles IS: 4860 : Specification for acid resistant bricks IS: 5518 : Code of practice for laying of flexible PVC Sheet and tile flooring. IS: 5491 : Code of practice for laying in situ granolithic floor topping.				
5.00.00	RATES AND MEASUREMENT				
5.01.00	Rates Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc. Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.				
5.02.00	Measurement				



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The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.



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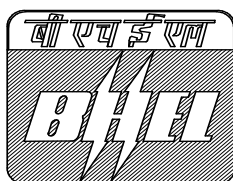
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SHEET WORK IN ROOF AND SIDING



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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SHEET WORK IN ROOF AND SIDING**1.00.00 SCOPE**

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION**2.01.00 Storage of Materials**

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

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2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

**2.02.04 PERMANENT COLOUR COATED SANDWICHED INSULATED METAL
CLADDING SYSTEM**

- i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF₂) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.
- ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm.
- iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.
- iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.
- v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.

**2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL
CLADDING SYSTEM**

- i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having

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minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF₂ paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii. FLASHING, CAPS, TRIM CLOSURES ETC.

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

- a) Side and end laps
- b) Absence of cracks, holes or damages in sheet
- c) Spacing of bolts
- d) Provision of double washers (G.I. and asbestos or bituminous washers)
- e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007 : Code of practice for laying of asbestos cement sheets.

IS: 2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

IS: 1626 : Specification for asbestos cement building pipes, gutters and fittings.



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IS: 277 : Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in “Schedule of Items” and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps in sheeting works.



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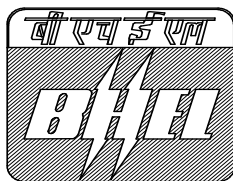
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SUSPENDED CEILING



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2.00.00

INSTALLATION

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3.00.00

SAMPLES

4

4.00.00

SHOP DRAWINGS

4

5.00.00

ACCEPTANCE CRITERIA

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SUSPENDED CEILING**1.00.00 SCOPE**

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. 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.

2.00.00 INSTALLATION**2.01.00 Suspension System****2.01.01 General**

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 works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,



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unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels**2.02.01 Material**

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

- a) Plaster of Paris board (decorative)
- b) Expanded polystyrene insulation board with plastic fascia.
- c) Fibre Insulation board.
- d) Bonded wooden particle board (Plain and decorative)
- e) Glass fibre reinforced polystyrene sheets.
- f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C " or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.



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Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels 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 module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00**SAMPLES**

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00**SHOP DRAWINGS**

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

- A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.
- Typical Intermediate framing for support where required.
- Hanger fastening details.
- Panels - unit support at ceiling penetrations.
- Details of splicing method for main and cross runners.
- A table indicating load bearing capacity of main and cross runner
- A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.



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5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT**6.01.00 Rates**

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.



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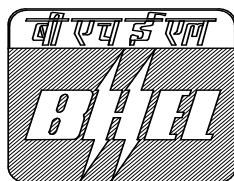
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**WATER SUPPLY, DRAINAGE
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WATER SUPPLY, DRAINAGE AND SANITATION**1.00.00 SCOPE**

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:



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- a) Cast Iron pipe
- b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)
- c) Concrete pipe
- d) Asbestos cement pipe
- e) PVC pipe
- f) Stoneware pipe
- g) Vitrified pipe
- h) Lead pipe (not to be used for portable water)

2.02.01

Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) **European type**

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic



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cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) Squatting type

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.



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Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION**3.01.00 General**

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the



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Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines**3.02.01 Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole



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connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS**3.03.01 Pipes**

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.



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Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients



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If not specified the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:



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- a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.
- b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.
- c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.
- d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines into any building or structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped



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immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be



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used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or



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other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of



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one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.



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3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leakproof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL**3.06.01 Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.



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3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA**4.01.00 Inspection Before installation**

All pipes, fittings, and appliance shall be inspected, before delivery at the site



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to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line**4.02.01 Testing of Mains After Laying**

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:



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a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

- i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and
- ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror



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will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt.XVI)	:	Laying of water and sewer lines, including appurtenant items.
IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt.I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.

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IS: 1592		:	Asbestos cement pressure pipes,			
IS: 1626		:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).			
IS: 2065		:	Code of Practice for Water Supply in buildings.			
IS: 2501		:	Copper tubes for general engineering purposes.			
IS: 2556		:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement			
IS: 2633		:	Method of testing, uniformity of coating on zinc coated articles.			
IS: 3076		:	Low density polyethylene pipes for portable water supplies.			
IS: 3486		:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter).			
IS: 3589		:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).			
IS: 4827		:	Specification for electro plated coatings of nickel and chromium on copper and copper alloy.			
IS: 4964		:	High-density polyethylene pipes for portable water supplies.			
IS: 12701		:	Rotational moulded polyethylene water storage tanks			
6.00.00	RATE AND MEASUREMENT					
6.01.00	RATE					
6.01.01	G.I. Pipes For Water Supply					
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.					
6.01.02	Rainwater Down-comers					
	Rate shall include providing and fixing of the pipes including all specials and					

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		fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.			
6.01.03	Sanitary Fixtures	Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of “Schedule of Items”. Rate shall also include the jointing of waste & traps to drain pipes.			
6.01.04	Drainage and Sewer Pipes	Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.			
6.01.05	Floor and Gully Traps	Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in “Schedule of Items”.			
6.01.06	Manholes, Septic Tank, Soak Pit and Cover	Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.			
6.01.07	Water Storage Tank	The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.			
6.02.00	MEASUREMENTS				
6.02.01	Pipe for Water Supply and Drainage	For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.			
		The pipe shall be measured separately according to dia. and class of pipe.			
		Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.			



TITLE:

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6.02.02

Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in "Schedule of Items".

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in "Schedule of Items".



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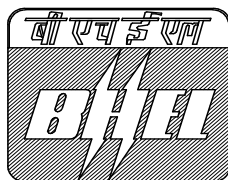
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SUB-SECTION – D16

ROAD AND DRAINAGE



Bharat Heavy Electricals Limited
Project Engineering Management



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C O N T E N T

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1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

- a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.
- b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.
- c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.



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1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

- a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC
- b) IRC: 19 - Standard specification and code of practice for Water bound Macadam
- c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways
- d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.
- e) IS:2212 - Code of Practice for Brick work
- f) IS: 783 - Code of Practice for Laying of Concrete Pipes
- g) IS: 1201 - Methods of testing tar and bituminous materials to 1220
- h) IS: 73 - Specification for paving bitumen
- i) IS: 215 - Specification for Road tar
- j) IS: 216 - Coal tar pitch
- k) IS: 217 - Specification for cut-back bitumen
- l) IS: 454 - Specification for cut-back bitumen from waxy crude
- m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete
- n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type



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Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

- o) IS : 334 - Glossary of terms relating to bitumen and tar
- p) IS: 1077 - Common burnt clay building bricks
- q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)
- r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements
- s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of $\pm 25\text{mm}$ therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be $\pm 40\text{mm}$.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.



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Sub-grade ± 25 mm
Sub-base ± 20 mm
Base course ± 15 mm
Wearing course ± 10 mm

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

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8



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5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

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

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

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost



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shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.



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Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.



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3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under



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construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

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

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06

Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.



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Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as



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shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

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

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall



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be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

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

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted



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thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm. The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall



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conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous



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matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the



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specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640**	50 percent maximum 40 percent maximum
2.	Base	a) Loss Angeles Abrasion value* or Aggregate Impact Value b) Flakiness Index ***	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640 ** IS : 2386 (Part I)	50 percent maximum 40 percent maximum 15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

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

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.



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b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.



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As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

**Table - VII
Grading For Screenings**

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm	100
		10.0 mm	90 - 100
		4.75 mm	10 - 30
		150 micron	0 - 8
B	10 mm	10 mm	100
		4.75 mm	85 - 100
		150 micron	10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03

Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke



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If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the



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surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

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

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

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

f) Sprinkling and Grouting

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

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers



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at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen



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shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII
Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum



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4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

**Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous
Macadam**

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

**Table-X
Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam**

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 - 100
12.5 mm	10 - 30	-
10 mm	-	35 - 60



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4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

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

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to



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ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit

manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still



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at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates



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The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

**Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick
Open Graded Premix Carpet**

Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
Total		0.27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0.18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
Total		14.6 Kg

3.11.03

Construction Operation

a) Weather and Seasonal Limitations



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Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress



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toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

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

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

3.12.02 Materials

a) Binder



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The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

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

3.12.03

Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.



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Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.



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Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of



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IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permited by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.



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b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The



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channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.



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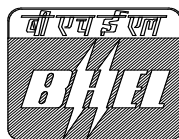
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**SECTION - D
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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK



Bharat Heavy Electricals Limited
Project Engineering Management



TITLE:

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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- f) Suitably mark, bundle, and pack for transport all fabricated materials.
- g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- h) Insure, load and transport all fabricated steelwork field connection materials to site.

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- i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

- IS : 226 - Structural steel (Standard Quality)
- IS : 800 - Code of Practice for general construction in steel.
- IS : 806 - Code of practice for use of steel tubes in general building construction.
- IS : 808 - Rolled steel beams, channels, and angle sections
- IS : 813 - Scheme of symbols for welding
- IS : 814 - Covered electrodes for metal arc welding of structural steel
- IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.
- IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel
- IS : 817 - Code of practice for training and testing metal arc welders
- IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations
- IS : 822 - Code of practice for inspection of welds
- IS : 919 - Recommendations for limits and fits for Engineering

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- IS : 961 - Structural Steel (High Tensile)
- IS : 1148 - Rivet bars for structural purposes
- IS : 1149 - High tensile rivet bars for structural purposes
- IS : 1161 - Steel Tubes for structural purposes
- IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)
- IS : 1239 - Mild Steel Tubes
- IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)
- IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and 1 locknuts (dia, range 6 to 39 mm)
- IS : 1367 - Technical supply conditions for threaded fasteners
- IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel
- IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube
- IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.
- IS : 1731 - Dimensions for steel flats for structural and general engineering purposes
- IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products
- IS : 1977 - Structural steel (ordinary quality) St-42-0
- IS : 2062 - Steel for General Structural Purposes
- IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming
- IS : 2595 - Code of Practice for Radiographic Testing
- IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel
- IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles

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- IS : 3757 - High strength structural bolts
- IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products
- IS : 7205 - Safety Code for Erection of Structural Steelwork
- IS : 7215 - Tolerances for fabrication of steel structures
- IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.
- IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used**2.05.01 General**

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and

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amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02**Steel**

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural steel High Tensile
- c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03**Rivet Steel**

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

- a) IS : 1148 - Rivet Bars for structural purpose
- b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04**Electrodes**

All electrodes to be used under the Contract shall be of approved reputed manufacture and shall comply with any of the following Indian Standard Specifications as may be applicable

- a) IS : 814 - Covered electrodes for metal arc welding of structural steel
- b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel
- c) IS : 1442 - Covered electrodes for the metal arc welding of high

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tensile structural steel

- d) IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 $\sqrt{A}$, where "A" is the cross sectional area of the test specimen

- i) IS: 1367: Technical supply conditions for threaded fasteners
- ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural Steel (High Tensile Quality)
- c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0
- d) IS : 6649 - Hardened washers

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2.05.07	Paints Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.	
2.06.00	Coal Bin	
2.06.01	Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.	
2.06.02	For general requirements, fabrication and construction details IS: 9178 (Pt.1 & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.	
2.06.03	The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.	
2.06.04	Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.	
2.06.05	Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.	
2.07.00	New Erection Marks	
2.07.01	Additional structures involving new erection marks may be required to be added at any stage of work.	
2.07.02	All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.	
2.07.03	All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.	

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2.08.00	ELECTRO FORGED STEEL GRATINGS
2.08.01	Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.
2.08.02	All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.
2.08.03	The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.
2.08.04	The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.
2.08.05	Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.
2.08.06	The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.
2.08.07	Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.
2.08.08	Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.
2.08.09	Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

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2.08.10	Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.	
2.08.11	The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.	
2.08.12	Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.	
2.08.13	All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two: (a) Two coats of red lead primer and two coats of black enamel finish paint. (b) Hot dipped galvanization at 610 gm/sq.m. in the shop prior to erection at site, as the approved drawing.	
2.08.14	Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.	
2.08.15	Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.	
2.09.00	GALVANIZATION OF GRATINGS	
2.09.01	Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15	
2.09.02	After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).	
2.09.03	The weight of the zinc coating shall be at least 610 gm/m ² - unless noted otherwise.	
2.09.04	The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to	

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	the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection. 2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633. 2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose. 2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection. 2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains. 2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner. 2.10.00 STAINLESS STEEL HOPPERS 2.10.01 Material Stainless steel hopper of grade SS 4 15M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used. <table> <tr> <th>Material</th><th>%</th><th>Remarks</th></tr> <tr> <td>Carbon</td><td>10.03%</td><td>Max.</td></tr> <tr> <td>Silicon</td><td>1.60%</td><td>Max.</td></tr> <tr> <td>Manganese</td><td>0.80% to 1.50%</td><td></td></tr> <tr> <td>Phosphorous</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Sulphur</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Chromium</td><td>10.80% to 12.50%</td><td></td></tr> </table>		Material	%	Remarks	Carbon	10.03%	Max.	Silicon	1.60%	Max.	Manganese	0.80% to 1.50%		Phosphorous	0.03%	Max.	Sulphur	0.03%	Max.	Chromium	10.80% to 12.50%	
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Nickel 1.50% Max.

Titanium 0.75% Max.

Nitrogen 0.03% Max.

The mechanical properties shall be as follows:

Description	Value	Remarks
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

- Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.
- The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store



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will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

- c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct

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dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS**2.11.01 PTFE (Poly tetra fluorethylene) slide bearing****a) General**

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the

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top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material**2.12.01 General**

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in

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sealed containers shall be used up as soon as possible once the container is opened.

2.13.00**Quality Control**

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

- a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- b) Rivets, Bolts, : Manufacturer's certificate, dimension checks, Nuts & Washers material testing.
- c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- d) Welders : Qualifying Tests
- e) Welding sets : Performance Tests
- f) Welds : Inspection, X-ray, Ultrasonic tests
- g) Paints : Manufacturer's certificate, physical inspection reports
- h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated



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Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolts location etc.
- c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.
- d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication,

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erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP**3.01.00 Fabrication****3.01.01 General**

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically

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controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction**3.02.01 Holes**

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm

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(depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02**Assembly**

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and

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special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction**3.03.01 General**

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm

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or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

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. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm 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. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.

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To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butt over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

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3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall

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be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

- a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.
- b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.
- c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

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3.15.00	Shop painting	
3.15.01	General Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer. After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.	
3.15.02	Inaccessible parts Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.	
3.15.03	Contact surfaces Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.	
3.15.04	Finished surfaces Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.	
3.15.05	Surfaces adjacent to field welds Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.	

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3.16.00	Galvanizing	
3.16.01	General	
	Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.	
3.16.02	Surface Preparation	
	All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.	
	The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.	
3.16.03	Procedure	
	Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.	
	After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.	
	The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.	
	Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken	

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not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY**4.01.00 Inspection**

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria**4.02.01 General**

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

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4.02.02**Welding**

- a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.
- b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:
 - i) 10% at random on fillet-joints.
 - ii) 100% on all butt-joints.
- c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.
- d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04**Rivets, bolts, nuts and washers**

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05**Shop painting**

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

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4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials**4.05.01 General**

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

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4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

- a) Name and address of the consignee
- b) Name and address of the consignor
- c) Gross weight of the package in tonnes and its dimensions
- d) Identification marks and/or number of the package
- e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

- a) Name of the Contractor
- b) Number and date of the Contract
- c) Name of the office placing the contract
- d) Nomenclature of stores

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- e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED**5.01.00 With Tender**

The following information is required to be submitted with the Tender:

- a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

- i) Preparation and approval of fabrication drawing
- ii) Procurement of Materials
- iii) Fabrication and shipping of all anchor bolts
- iv) Fabrication and shipping of main steelwork.



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- v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.
- vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.
- vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

- a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.
- b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.
- d) Results of any test as and when conducted and as require by the engineer.
- e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any.

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	For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications. 6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures. 6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work. 6.01.04 No claims shall be entertained, if the details shown on the 'Released for Construction' drawings differ from those shown on the bid/tender drawings. 6.01.05 Rates shall be inclusive of all leads and lifts/elevation. 6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work. 6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of materials not issued by the Owner. 6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the zinc silicate primer.	

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- 6.01.09** The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.
- 6.01.10** The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.
- 6.01.11** The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.
- 6.01.12** The bidder's rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.
- 6.01.13** The bidder's rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.
- 6.01.14** The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unblized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.
- 6.01.15** The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

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6.01.16	The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.
6.01.17	The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.
6.01.18	The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.
6.01.19	The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner for this item of work shall supply no material.
6.02.00	MODE OF MEASUREMENT
6.02.01	The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.
6.02.02	The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

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6.02.03	For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.				
6.02.04	Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds the area shall be assumed as the minimum circumscribed rectangle.				
6.02.05	For bunker wall plates the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).				
6.02.06	For all other plates, where the area of any notch/skew cut in the plate is less than 0.2 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.2 sq.m. the actual profile of the plate shall be considered for the purpose of payment.				
6.02.07	No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.2 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.2 sq.m.				
6.02.08	All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.				
6.02.09	The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.				
6.02.10	The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.				
6.02.11	The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.				
6.02.12	The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for				

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	erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units. 6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer. 6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules. 6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules. 6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below 6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured. 6.02.20 For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark. 6.02.21 For re-erection the weight of the modified erection mark shall only be measured. 6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner	

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	similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel. 6.02.23 The measurement for the item of PTFE bearings shall be based on the actual weight in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings. 6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate. 6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer. 6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.	



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SUB-SECTION – D XVIII

ERECTION OF STRUCTURAL STEELWORK



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SUB-SECTION – D XVIII**ERECTION OF STRUCTURAL STEELWORK****1.00.00 SCOPE**

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.
- b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures.

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g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

- i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
- ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.
- iii) Reaming of holes for use of higher size rivet or bolt if required.
- iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.
- v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
- vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

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

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions of the Engineer.

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2.05.00	Material	
2.05.01	General	
	All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.	
2.05.02	Materials to conform to Indian standards	
	All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.	
2.06.00	Storage of Materials	
2.06.01	General	
	All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.	
2.06.02	Yard	
	The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.	
	The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.	
2.06.03	Covered Store	
	All field connection materials, paints, cement etc. shall be stored on well	

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		designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.			
2.07.00	Quality Control				
		The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :			
		i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.			
		ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.			
		iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.			
2.08.00	Taking Delivery				
		The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.			
		The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.			
3.00.00	WORKMANSHIP				
3.01.00	Erection				
3.01.01	Plant and Equipment				
		The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.			

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3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.



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No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight' is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I



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Bolts length not
exceeding 8 times
dia or 200 mm

Bolt length
exceeding 8 times
dia or 200 mm

Remarks

1/2 turn

2/3 turn

Nut rotation is relative to
bolt regardless of the
element (nut or bolt)
being turned.
Tolerance on rotation-30°
over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14. 7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least

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once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after



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reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, "ironite" or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural

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steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA**4.01.00 General**

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable



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and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.



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When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection	



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levels:

i) For a column upto and including 10M height ± 3.5 mm from true vertical

ii) For a column greater than 10M but less than 40M height ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ± 7 mm per 30m length.

c) For adjacent pairs of columns across the width of the building prior to placing of truss ± 9.0 mm on true span.

d) For any individual column deviation of any bearing or resting level from levels shown on drawings. ± 3.0 mm

e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating 3.0 mm

Trusses
least.
a) Deviation at centre of span of upper chord member from 10mm vertical plane running through centre of bottom chord. $1/1500$ of the span or not greater than whichever is the least.

Trusses
b) Lateral displacement of top chord at center of span from vertical plane running through center of supports. $1/250$ of depth of truss or 20 mm which ever is the - least.

Crane Cirders
a) Difference in levels of crane rail measured between adjacent columns. 2.0 mm.

b) Deviation to crane rail-gauge ± 3.0 mm



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c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding. 1.0 mm.

d) Deviation of crane rail axis from centre line of web. ± 3.5 mm

Setting of Expansion gaps At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the

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job in time in accordance with the Contract.

5.01.02

Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03**Erection Yard**

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00**After award of the Contract**

After award of the contract, the Contractor shall submit the following:

5.02.01**Detailed Programme**

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02**Fortnightly Progress Report**

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.



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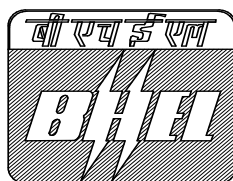
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SUB-SECTION – D19

ROOF DECKING



Bharat Heavy Electricals Limited
Project Engineering Management



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ROOF DECKING**1.00.00 Scope**

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deareator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 275 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings



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and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing**3.02.01 Sequence of Manufacture/Erection**

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.



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3.02.06 Laps

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's recommendations using tools



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approved by the manufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

- a) Side and end laps
- b) Absence of damage in the sheeting.
- c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- IS : 513 - Specification for cold rolled carbon steel sheets.
- IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.
- IS : 4431 - Specification for carbon & carbon manganese free cutting steel.
- IS : 1573 - Electroplated Coatings of zinc on iron and steel.



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6.00.0 RATES AND MEASUREMENTS**6.01.00 Rates**

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.



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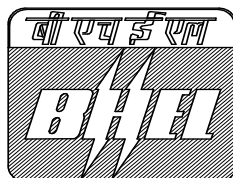
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FALSE FLOORING



Bharat Heavy Electricals Limited
Project Engineering Management



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FALSE FLOORING**1.00.00 General**

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL**2.01.00 Supporting structure**

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of ± 0.2 mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of ± 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for



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cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.



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Any damage to the sub floor during installation of the false flooring system shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorised representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks :

- Level
- Alignment of joints
- Thickness of joints
- Surface finish
- Colour and texture
- Details of edges, junctions etc.
- Performance



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h. Criteria specified for strength.

5.00.00**IS CODES**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0**RATES AND MEASUREMENTS****6.01.00****Rates**

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00**Method of Measurement**

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.