

8.3 Transformers

Refer relevant section for the transformer tests.

8.4 Circuit Breakers

Check alignment of breaker trucks for free movement, check correct operation of shutters, check control wiring for correctness of connections, continuity and IR values, contact resistance as all three phases. Breaker closing and tripping time, simultaneous closing of all three phases, pole discrepancy tests for single phase breaker, check electrical & mechanical interlocks provided.

8.5 Disconnectors

Simultaneous closing of all phases.

8.6 Distribution Boards

Power frequency high voltage test, insulation resistance test, operation tests.

8.7 Voltage Transformers

Open delta test with low voltage, wherever required, measure core loss from LV side, Voltage ratio measurement with low voltage.

8.8 Current Transformers

Capacitance and tan delta test, magnetization characteristics, current ratio measurement.

8.9 Relays

Check of external wiring, relay settings, secondary current injection and trial tripping.

9.0 Taking over

No items of substation will be certified for 'Taking Over' unless it has passed all the tests.

A 'Taking Over' certificate for substation will be issued only after the requisite documentation of commissioning tests are duly compiled and approved by the Owner.

10.0 Civil Works for Switchyard

10.1 General

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This part covers the requirements for design, manufacture, testing, supply and construction of civil and structural steel works of the switchyard.

The Contractor shall perform the works to comply with the requirements of this specification and shall assume full responsibility for their satisfactory performance.

10.2

Scope of Work

The scope of works for all civil, architectural and structural works shall include planning design, design and drawings to approval, engineering procurement, construction, testing and commissioning of all the works as well as providing all labor, qualified supervisory personnel, materials, consumables, instruments, tools, erection plant and equipment, fixtures, fittings transportation, all temporary and permanent works necessary and all incidental items not shown or specified but reasonably implied or necessary for completion and proper functioning of switchyard, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.

All materials including cement, reinforcement steel, structural steel etc., shall be arranged by the Contractor.

It shall be noted that the Contractor will have to complete all these works so that the switchyard is handed over to the Owner 'ready to use'. Specific items of work involved are excavation, site-grading and back-filling, construction of foundations and erections of structural steel supports of switchyard, site development including drains, roads, fencing and gates, construction of control building and miscellaneous items like water and sanitation, revetment walls etc.

The work shall be carried out according to the design and drawings to be developed by the Supplier and as approved by the Owner. For all buildings and structures, foundations etc., necessary layout and details are to be developed by the Supplier keeping in view the statutory and functional requirements of the plant and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Supplier shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Owner.

10.3

Design Standards

Switchyard structures and footings shall be designed on the basis of loads, permissible stresses and other relevant design provisions given in this Agreement and in the latest revisions of the relevant IS codes, mainly IS:802 and IS:456 of Bureau of Indian Standards, New Delhi. Reference shall be made to other IS codes as and when required. All codes referred to herein shall be the latest editions issued by the Bureau, irrespective of

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the year of publication mentioned herein. In case of conflict between the specification given herein and the IS code provisions, the more demanding requirement shall be satisfied.

Any details not specifically covered by this specification shall be subject to the approval of the Engineer / Owner.

10.4 Submission of Design and Drawings

The Supplier shall submit detailed analysis, design and construction drawings of support members, foundations and all other structural members, for the approval of the Engineer who shall have the right to instruct the Supplier to make any changes therein to make the construction conform to the requirement of the specification. Construction shall commence only on approval of design and construction drawings by the Engineer.

One set of design calculations and single line drawings indicating member sizes, of one Gantry structure and one equipment structure, shall be submitted at the time of bid and similar calculation and drawings for other structures shall be submitted by the Supplier for approval by the Owner/Engineer. A rigorous checking will be made only prior to construction and the Supplier without any extra cost to the Owner shall rectify any errors found on rigorous checking. The same conditions shall apply to all other design calculations and drawings submitted for the Engineer's approval.

Hand-analysis methods may be used in case of simple supports like cantilever or portal frames where well-established, proven formulate are available, but an approved computer program shall be used for the Three Dimensional Space structure analysis of indeterminate supports. All information necessary for the approval of the analysis and design of all the structures and their foundations shall be submitted to the satisfaction of the Engineer, in hard copy form and in electronic form on floppy diskettes. For other requirements governing designs, drawings and submission see other relevant clauses included in these specifications.

10.5 Steel Structure Supports

10.5.1 Analysis and Design of Structures

10.5.1.1 Loads

Loading from electrical equipment / components considering their self-weight, wind loading, torsional moment induced due to operational movements of equipment components, impact loads of equipment and any other loads, as applicable.

- a) Wind loadings on electrical equipment / components, structures, insulators, conductors/bus bars/ground wire shall be as per IS 802 (part 1 / sec1) considering the following:

- Wind zone -2
- Reliability level - 1
- Terrain category -2

In the case of structures, insulators, conductors and ground wires, relevant criteria for load calculations stipulated in IS 802 (Part 1 / Sec 1) shall be considered. In case of bus bars and other round surfaces criteria similar to that for conductors shall be followed. In case of flat surfaces criteria similar to structures shall be followed;

- b) Vertical load due to weight of a lineman with tools per conductor support for bus bar structure / gantry structure: 150 Kg.
c) Tension load due to per sub-conductor of incoming line: 1000 kg
d) Tension load due to incoming line ground wire: 800 kg
e) Tension due to switchyard shield wire: 500 kg

The line terminating gantry structure shall be designed for incoming conductors and ground wire with angle of deviation of 30°C both horizontally and vertically. For design purpose, the line terminating structure is situated at 75 mtrs from incoming line terminal tower. Wire tensions shall be assumed as acting only on one side to get the worst loading criteria.

- f) Short circuit force: To be calculated based on a short circuit current of 40 kA.

Details of conductor and ground wire are specified elsewhere in the document.

10.5.1.2 Combination of Loads

For the design of the structures, simultaneous application of loads as indicated in Clauses 10.5.1.3 and 10.5.1.4 shall be considered. The direction of wind should be assumed such as to produce the maximum stress in any member for the combination of wind load and wire tensions. For this, conditions of wind acting perpendicular and parallel to bus conductor and shield wire shall be considered separately.

10.5.1.3 Normal condition

Strung Bus Bars

- a) Wind load on bus bars, shield wires, insulator strings, electrical equipment, structure members etc.
b) Unbalanced loads due to wires tension acting on one side to get maximum design loading considerations.
c) Dead loads of wires, insulators, electrical equipment and structural members.

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Rigid Bus Bars

- a) Wind loads on bus bars, shield wires, electrical equipment, structure members etc.
- b) Dead loads of bus bars, post insulators, electrical equipment and structural members.

10.5.1.4 Abnormal Conditions

Short Circuit Condition

In addition to the combination of loading in Clause 10.5.1.3, short circuit forces shall be considered for the design of structural members.

10.5.1.5 Load Factors

The ultimate loads shall be calculated by multiplying the loads obtained above, by load factors as given here.

Load factors shall be taken as 2.0 under normal condition and 1.5 under abnormal condition.

10.5.1.6 Permissible Stresses

The permissible stresses shall be considered as per IS 802 (Part 1 / Sec 2) for structural steel members and connection bolts.

10.5.2 Material

10.5.2.1 Steel

The structural steel shall conform to IS 2062 Grade A.

10.5.2.2 Zinc

Zinc used for galvanizing shall be of 99.95% purity.

10.5.2.3 Bolts, Nuts and Washers

All hexagon head bolts, mating hexagon nuts and plain washers shall satisfy the requirements specified in IS 12427 including their hot-dip galvanizing.

10.5.2.4 Sectional Properties of Support Structure Members

Structural steel sections shall conform to IS 808.

10.5.2.5 Design and Detailing of Support structure Members

The Supplier shall be required to keep in consideration the following points while designing and detailing the structures:

- a) All the members shall be designed out of structural mild steel sections and plates having their sizes and properties as per relevant Indian Standard Specification. The structure shall be bolted type.

Use of mild steel rounds will be permissible only for making the hangers or U-Bolts or extension links for supporting the insulator strings and earth wire clamps at the support structure for which welding may be permitted, if considered necessary.

- b) All parts shall be made accurately to standard gauges so as to facilitate replacement and repairs. All corresponding parts of similar support structures shall be interchangeable.
- c) Members shall be connected directly to each other without use of gusset plates, wherever practicable.
- d) All the connections shall be detailed to minimize eccentricity of the conditions.

10.5.3

Fasteners and Joints

The provisions of Clause 5 of IS 802 (Part II) shall be followed, unless noted. While dimensioning the gauge lines, allowances should be kept for mill rolling tolerance on negative side to the extent of 2.5% of the flange width.

The distance from the centre of a bolt hole to the face of the overhanging flange of an angle or other members would be adequate for conveniently tightening the bolts by socket wrench or box spanners. Bolt at the joint shall be so staggered that nuts may be tightened with spanners without fouling.

All measurements should be done from the outer heel edge.

Hot dip galvanized plain washers of 5 mm nominal thickness shall be provided for insertion under all nuts. The length of bolts shall be determined considering this.

Step-bolts, Nuts and Washers.

Each gantry structure shall be provided with step-bolts of an approved type 16mm dia and 175 mm long on two diagonally opposite corner legs at not more than 380 mm centre starting 0.5 m above the Finished Ground Level and continuing to the earthwires.

Step-bolts, nuts and washers shall conform to the requirements of IS 10238 including their hot-dip galvanizing.

10.5.4 Materials and Workmanship

Unless otherwise specified all material shall be of out-door type, of the best quality and workmanship capable of satisfactory operation under the operating and atmospheric conditions specified. Unless otherwise specified herein, the materials shall conform, in all respect, to the requirements of the latest edition of the relevant Indian Standard specifications on that behalf. Wherever Indian Standard specifications have not been formulated, IEC shall apply.

Supplier may offer materials manufactured in accordance with other well recognized standards, but shall in that case supply a copy of the standard specifications adopted by them and shall clearly mention in what respect such standard specification differ from corresponding Indian Standard Specifications.

However, material quality and strength should in no case go below the stipulation and requirements of IS.

All materials shall be erected after being approved and passed by the Engineer / Owner.

10.5.5 Fabrication and Workmanship

The support structure members shall be fabricated in accordance with IS 802 (Part-II). The following important points relevant to fabrication work are described. The Owner reserves the right at all times to inspect the fabrication of support structure parts at the Supplier or Sub-contractor's works.

- a) All parts of support structures shall be fabricated in accordance with the shop drawings prepared from approved detailed assembly drawing.
- b) Structures shall have bolted connection. Welding shall not be permitted at any point unless otherwise previously approved by the Owner.
- c) The structure members shall be accurately fabricated so that these could be bolted together easily at site without undue strain on the bolts or members.
- d) No angle members shall have its two legs brought together by closing the angle.

- e) Structures shall be so designed that all parts shall be accessible for inspection and cleaning. The pockets or depressions, which would hold water, shall have drain holes. It will be ensured that the stressed members will not have any blank hole after final assembly, except for holes on account of step bolts or planned holes in stubs.
- f) Fabrication shall be carried out in conformity with the latest practice employed in the manufacture of transmission line support structures by using power driven cropping, punching, shearing and drilling machines. The extent of various operations shall be governed by relevant Indian Standards and the standard practice followed for such operations.
- g) No rough edge shall be permitted anywhere in the entire structure. The flanges of the angle sections at the ends of members shall be properly chamfered, if there are even slight chances of its fouling with other members or if they cause difficulty in proper tightening of the bolts. All clippings, back cuts, grindings, bends, holes etc., shall be true to detailed drawings and free from burrs.
- h) No welding filling or plugging shall be permitted unless previously approved. Welding of two or more pieces to obtain length of members specified will not be permitted.
- i) All sections, plates and bars shall be straightened before any work is done on them free from twists, carefully leveled and made true to detailed drawings by methods, which will not injure the materials so that when assembled the adjacent surfaces are in close contact throughout. Hammering shall not be permitted for straitening or flattening of members.
- j) Cutting of members shall be effected by shearing, cropping, flame cutting or sawing. Members over 10 mm thickness shall be sawn or flame cut followed by grinding. The surface so cut shall be clean, smooth, reasonably square and free from any distortion.
- k) Holes in the members shall be either punched or drilled with the help of jigs and fixtures. Drilled holes will be preferred. However, members upto 12mm thickness may be punched and members over 12mm thickness shall be drilled. All burrs left after drilling or punching should be removed completely. Holes adjacent to the bend shall be drilled or punched after bending.
- l) Holes for bolts shall be circular. Oval or lobbed forms of holes shall not be permitted. The diameter of hole shall be 1.5 mm more than the diameter of bolts.
- m) The holes shall be perpendicular to the plates or angles.

- n) The accuracy of location of holes shall be such that for any group, when assembled, it shall admit the bolt at right angles to the plane of connection.
- o) Members shall be bent hot, but in case of small bends, cold bending may be done with the prior approval of the Engineer, provided no fracture of material occurs. All the bending operations shall be done by pressure. No bending of members shall be done for slope above 45° .
- p) When members are spliced by a lap joint, heel of inside angle shall be rounded to the minimum possible radius consistent with proper fit with the fillet of the outside angle. The thickness of the ground heel shall not be less than that of the leg. Flat heeling will not be allowed.

10.5.6 Tolerances

The fabrication tolerances shall conform to those specified below. Tolerance not specified herein below shall generally conform to IS 7215.

- i) The maximum allowable difference in diameter of the hole on the two sides of plate or angle shall not exceed 0.8 mm i.e., allowable taper in punched hole shall not exceed 0.80 mm on diameter.
- ii) The tolerance cumulative and between consecutive holes shall be within $\pm 0.5\text{mm}$.
- iii) The tolerance on the overall length of members shall be with $\pm 1.6\text{mm}$.
- iv) The tolerance on gauge distance shall be within $\pm 0.5\text{mm}$.

10.5.7 Marking

All parts covered under supply of the structures shall have distinct marks, as given in the detailed assembly drawing and bill of material, stamped before galvanizing, with marking dies of 16mm size. The letters shall indicate the type of structure in which the members is to be used and numeral shall indicate the member mark as per drawing and bill of material. These erection marks shall be stamped near one end and in the same relative position on each piece, in such a way that the mechanical properties of members are not affected. Special care must be taken to stamp the correct erection mark. The Contractor shall be entirely responsible for any disruption of work, delay in completion of line, delay in payment of bill on account of wrong erection marks.

10.5.8 Galvanizing

All members of the steel structures including stubs along with the cleats, bolts and nuts, fixing attachments for insulator strings and earthwire clamps, extension links, if any shall be galvanized.

The galvanizing shall be done after all fabrication work is completed on the members by hot-dip process. Bolts and other fasteners shall be galvanized in accordance with IS 5358 and galvanizing of structural members shall conform to IS 4759. Material to be galvanized is to be kept free from grease and paint etc., during and after fabrication. After galvanizing, the surface shall be free from all sharp edges and metal modules and there shall be no clogging of bolt holes due to stay of zinc.

Tests on the galvanized samples of fabricated materials shall be carried out regularly in accordance with IS 2633. If the galvanizing does not satisfy testing requirements the entire batch represented by the sample piece shall be rejected and re-galvanized to satisfy the test requirements without any extra expenditure to the Owner's account.

All galvanized support structures and accessories shall be treated with sodium dichromate or an approved equivalent solution after galvanizing so as to prevent white storage strains.

In addition, the Supplier before dispatch shall carry out strict inspection of the galvanized material and any visible or suspected defects shall be rectified forthwith.

10.5.9

Packing

Light angle sections shall be wire bundled and heavy angle sections may be sent loose.

Cleat angle, plates, hangers, U-bolts, pack washers and similar loose piece shall be nested and bolted together in multiples or securely wired together through holes.

Bolts, nuts, washers and other attachments shall be packed in non-returnable double gunny bags and accurately tagged in accordance with contents. The packing shall be done in such a manner so as to avoid losses / damages during transit. Each bundle or package shall be appropriately marked.

10.5.10

Inspection

The Owner or his representative shall have free access at all reasonable times to those parts of the Supplier's/ Contractor's works which are concerned with the fabrication and galvanizing of the steel work and shall be provided all reasonable facilities for satisfying himself that the fabrication, galvanizing and packing is being done in accordance with the

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provisions of this specification. Unless specified otherwise, inspection shall be made at the place of manufacture, prior to dispatch.

No member, once rejected for lack of conformity to the specifications, shall be re-offered for inspection, except in cases where the Owner or his authorized representative considers the defect as rectifiable.

Defects, which may appear during fabrication, shall be made good with the consent of and according to the procedure laid down by the Owner.

The Supplier shall supply all gauges and templates necessary for inspection of fabricated material.

The Supplier shall use the correct grade and quality of steel and zinc. To ascertain the quality of steel / zinc used, the Owner may at his discretion, get the raw and fabricated material tested at an approved laboratory.

10.6 Foundations

10.6.1 General

Reinforced Cement Concrete (RCC) type individual footings shall more be preferred foundations for all equipment structures and gantry. However, where the same are found to be uneconomical and if the Engineer permits, individual Plain Cement Concrete (PCC) footings may be provided. The Supplier shall submit the detailed designs and drawings for the foundations of all structures, for the approval of the Engineer.

10.6.2 Loads on Foundations

The foundations shall be designed to withstand the reactions at structure foundation obtained from the structural stress analysis. The reactions shall be further increased by 10% (i.e., multiplied by a factor of 1.10) as compared to the super-structure reactions.

The base reactions shall be composed of the following:

- a) Maximum tension or uplift.
- b) Maximum compression or down-thrust
- c) Maximum horizontal shear or side-thrust.

10.6.3 Stability Analysis

The following primary types of soil resistances shall be assumed to act in resisting the loads imposed on the footings in earth:

- a) Resistance against Uplift:
The uplift loads will be assumed to be resisted by the weight of earth in an inverted frustum of a conical pyramid of earth on the

footing pad whose sides make an angle equal to the angle of repose of the earth with the vertical. Type weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift.

Every attempt shall be made to avoid over-lapping of frusta of adjacent footings. In an unavoidable case, where the frusta of earth pyramids of two adjacent legs superimpose each other, the earth frustum of each leg shall be assumed truncated by a vertical plane phasing through the center line of the tower base.

Inverted frustum of each shall be assumed to be applicable in non-rocky conglomerates only. In rocky soil other ways of considering uplift resistance like rock anchors, embedment in rock etc., shall be devised with the approval of the Engineer.

b) Resistance against Down Thrust

The down thrust loads will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings.

In the design of foundation for down-thrust, weight of concrete in the footing above and below ground level and embedded steel parts shall correctly be accounted for, giving due consideration to water-table. If present, and displaced earth.

c) Resistance against Side Thrust:

Side thrust shall be resisted by passive pressure acting on the side of the chimney, and/or by "at rest" soil pressure acting against the foundation slab and pyramid. In case this pressure is inadequate to resist the side thrust, help shall be taken of the friction of foundation against the ground, during down thrust condition only. For this, the co-efficient of friction between the ground and the concrete surface shall be taken as 0.2. This friction shall be deemed not to exist during uplift condition. In case the passive pressure on the chimney face is less than the side thrust, effect of the moment at the base of foundation on the base pressure shall be taken into account in the stability check and subsequently in the design of the foundation. In all cases, the chimney shall be designed as a cantilever, fixed at the foundation top, subjected to the side-thrust, without any relief from the passive pressure.

In case of back filling by rocky soils, horizontal soil pressures on chimney and foundation shall be taken as zero.

In case of rocky soils, resistance against side thrust shall be developed by casting the footing against the rock.

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d) Resistance against Overturning:

For resisting overturning, the weight of soil shall be assumed to be 50% of the weight of the earth contained in the inverted frustum of the cone. The inverted frustum of the cone shall be the same as that considered for resisting uplift as given above.

The following shall be considered during the stability analysis:

- i) The increase in ground reaction caused by a moment due to horizontal shear.
- ii) The reduction of uplift capacity caused by a moment due to horizontal shear.

10.6.4 Foundation Depth

For all soil other than hard rock, the total depth of foundations below the ground level shall not be less than 1.5m. Corresponding minimum depths for hard rock foundations shall be 0.6m.

The maximum depth of foundations for all types of equipment foundation and gantry foundation (except special structures and foundations approved by the Engineer), shall not be more than 3.5m below the ground level.

10.6.5 Design of Foundation

The strength design shall ensure safety against all stress resultants (viz., shear, bending and axial stresses) during each of the maximum down thrust and uplift conditions taken along with accompanying side thrusts. Particularly, the base slab shall be checked for stresses due to bending moment and shear force arising during down-thrust and uplift conditions, while the chimney portion shall be designed as a composite section for combined action of compression or tension force and associated bending moments due to horizontal shears. The anchoring of stub and cleat shall be done to check anchoring stress in down-thrust and uplift case.

The foundation shall be designed to satisfy all specified loading conditions.

The thickness of concrete in the chimney portion shall provide minimum cover of not less than 100mm from any part of the stub angle to the nearest outer surface of the concrete at all dry locations. At all wet locations the chimney shall have a clearance of 150 mm from any part of the stub angle.

The chimney top or muffing must be at least 225 mm above ground level and also the coping shall be extended upto the lower most joint level between the bottom lattices and the main corner leg of the tower.

The minimum distance between the lowest edge of the stub angle and the bottom surface of concrete footing shall not be less than 100mm or more than 150mm in case of dry locations and not less than 150mm or more than 200mm in case of wet locations.

The foundation shall be so designed that the Centre of Gravity (CG) of structure leg coincides with the CG of chimney & CG of chimney coincides with the CG of base pyramid or slab whichever is provided. In case this provision is not followed, the resultant eccentricities and additional forces because of eccentricities shall be considered in the design of foundations.

The portion of the stub in the pyramid shall be designed to take full down thrust or uplift loads by the cleats combined with the bond between stub angle and concrete in pyramid portion.

The RCC foundations shall be designed in accordance with Limit State Method prescribed in IS 456 employing the same properties of materials, permissible stresses and mode of design as specified therein.

Concrete grade for structural concrete shall be minimum M20 grade. 75mm thick lean concrete pad of M10 grade of the size of base of the footing will be provided below all foundations.

10.6.6 Control Building

Control building shall be RCC framed structure. Analysis and design shall be carried out in accordance with the relevant Clauses of IS 456, IS 875, IS 1893.

Concrete grade for structural concrete shall be of minimum M20 grade. 75mm thick lean concrete pad of M10 grade of the size of the footing will be provided below all foundations.

10.6.7 Topographic Survey

The Owner is also carrying out a survey of the project area. Owner will make the topographical survey report and drawings available to Supplier after the completion of the ongoing works. This shall be treated by Suppliers for reference only. It is the responsibility of the Supplier to verify the various features on his own before submission of bid. The Owner does not take any responsibility for correctness of various features and contour details. The Contractor is not eligible for any extra cost or any

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extension of time if the results from his detailed survey and actual conditions at site are at variance to any extent from the ground levels derived from the above mentioned topographical survey data.

10.7

~~Roads within the Switchyard~~

Typical cross section of asphalt roads, inclusive of the construction of soling, water bound macadam course and asphalt surface treatment, is indicated in the drawings attached. The construction shall be such as to satisfy provisions of all applicable IS and IRC codes, the more important ones of which are mentioned below:

IS:73	:	Specification for Paving Bitumen
IS:215	:	Specification for Road Tar
IS:217	:	Specification for Cutback Bitumen
IS:454	:	Specification for Digboi type Cutback Bitumen
IS:460	:	Specification for Test Sieves
(Part 1 to 3)		
IS:1077	:	Specification for common burnt clay building bricks.
IS:1124	:	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
IS:1195	:	Specification for Bitumen Mastic Flooring.
IS:1196	:	Code of Practice for Laying Bitumen Mastic Flooring
IS:1834	:	Specification for Hot Applied Sealing Compounds for Joints in Concrete.
IS:2386	:	Methods of tests for aggregates for concrete
(Part 1 to 8)		
IS:2720	:	Methods of Test for Soils: Part 5
(Part 5)		
IS:6241	:	Method of test for determination of stripping value of road aggregates
IRC:15	:	Standard specifications and code of practice for construction of Concrete Roads (Second Revision)
IRC:16	:	Specification for priming of base course with Bituminous primers.
IRC:17	:	Tentative specification for single coat Bituminous surface dressing.
IRC:19	:	Standard specification and code of practice for

Water bound macadam.

IRC:29 : Specification for bituminous concrete (Asphalt Concrete) for road pavement.

Ministry of Surface: Specification for road and bridge works
Transport (Roads
Wing)

It is the intent of this specification that the water bound macadam road be constructed first. This shall then be opened to traffic, as directed by Owner/Engineer. After such period of time as decided by Owner/Engineer, preferably when the major construction and/or erection activities within plant limits are over, Contractor shall rectify all defects, wear and tear, etc., and surface the road with asphalt wearing course treatment.

10.8 Geotechnical Investigation

Geotechnical and Geological Investigations are carried out at the site and the Owner will make the data available to Supplier on completion of the ongoing investigation works. However, this shall be considered by the Supplier for his reference only and Owner shall not be held responsible for correctness of data or interpretation in any of these reports. Supplier is advised to verify the contents of the data made available to him before submission of bids. There is no expressed or implied guarantee for the correctness of the data given in the report nor of the interpretation thereof. However, the Supplier has to entirely satisfy himself about the findings given in the data after the award of Contract. The Supplier is not eligible to increase his cost or demand any extension of time because of any variance from findings in the data and actual site conditions.

10.9 Earthworks

10.9.1 Excavation

10.9.1.1 Drawings

Based on the topographic and the geo-technical data for the switchyard, the Supplier will furnish drawings for the approval of the Engineer, showing his scheme for the areas to be excavated/filled, grade level, sequence of priorities etc., to achieve the most economic arrangement considering excavation, fill, amount of material used for structures, foundations, drainage systems etc. The Contractor shall strictly follow such drawings. The Supplier shall submit the most economic scheme, fixing the grade level/s at his discretion, but the final scheme shall be adopted only after the approval of the Engineer.

10.9.1.2 Cleaning

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400 kV Switchyard &
GT Yard

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush etc., and other objectionable matter which shall be disposed off as directed by the Engineer. Where earth fill is intended, the area shall be stripped of all loose/soft patches, topsoil containing objectionable matter/materials before fill commences.

It shall be noted and remembered that unauthorized tree cutting being an offence, any tree cutting shall be started only after the requisite permission has been obtained by the Owner from the concerned authorities for trees to be cut.

10.9.1.3 Precious Objects, Relics, Objects of Antiquity etc.

All gold, silver, oil, minerals, archaeological 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 Owner and from time to time deliver the same to such person or persons as the Owner may from time to time authorize or appoint to receive the same.

10.9.1.4 Classification

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

ORDINARY AND HARD SOILS

These shall include all kinds of soils containing kankar, sand, silt, murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "Soft and Decomposed Rock" and "Hard Rock" defined below. This shall also include embedded rock boulders not longer than 1 meter in any one direction and not more than 200 mm in any one of the other two directions.

SOFT AND DECOMPOSED ROCK

This shall include rock, boulders, slag, chalk, slate, hard mica, schist, laterite and all other materials which in the opinion of Engineer is rock, but does not need blasting and could be removed with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that the Contractor resorts to blasting for reasons of his own shall not qualify for classification under 'Hard Rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 meter in any direction and not more than 500mm in any one of the other two directions.

HARD ROCK

This shall include all rock occurring in large continuous masses, which cannot be removed except by chiseling, drilling or blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, in the opinion of the Engineer require blasting shall be considered as hard rock. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item.

10.9.1.5

General

The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas to avert accidents.

The item shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes as directed by the Engineer, within the lead specified and leveling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as directed by the Engineer.

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, the work involved and time schedule permit manual work.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer.

All excavation shall be done to the minimum dimension as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

The Contractor shall ensure that excavations are made to the correct depth and width. If excavations are taken too deep, the excess depth shall be back-filled with lean concrete at the Contractor's expenses. If excavations are made too wide, such modifications to the design as the Engineer may require shall be made at the Contractor's expense.

10.9.1.6 Stripping Loose Rock

All loose boulders, semi detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion, which was originally sound and safe.

10.9.2 Fill, Back Fill and Site Grading

10.9.2.1 General

All fill material, whether such material is brought from outside borrow areas or from excavation from within the site, will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited / disposed off as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and steams have been properly intercepted or otherwise dealt with as directed by the Engineer.

10.9.2.2 Material

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salt, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150mm size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

If any selected fill material is required to be borrowed, the Contractor shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc, top soil containing salts / sulphate and other foreign material shall be removed. The materials so removed shall be disposed off as directed by the Engineer. The Contractor shall make necessary access roads to borrow / areas and maintain the same, of such access road does not exist, at his cost.

It shall be Contractor's responsibility to locate suitable borrow areas for borrowing fill material. Such area will be inspected by the Engineer and approved before the Contractor makes arrangements to borrow the fill material. The top soil, which may contain vegetation, rubbish, slush etc.,

shall not be used. If demanded by the Engineer, the Contractor shall arrange to have trial pits of specified dimensions and numbers dug at locations specified for the Engineer to examine the nature and type of material likely to be obtained from the borrow area.

The borrowed soil shall be generally granular and non-cohesive. It shall consist of sand, silty sand, murrum, ordinary soil, gravel and shingle. Dredged material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Engineer shall be removed from the site immediately.

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

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

10.9.2.4 Plinth filling

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

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

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300mm. The Engineer will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used.

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

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At some locations / areas it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc., and he shall ensure proper compaction. Alternatively, the Contractor shall ensure necessary compaction by the passage of trucks, carrying the fill material over the deposited fill in such a way that the entire fill area is covered. This will reasonably compact the sand fill and will be accepted by the Engineer. However, the Contractor shall ensure that every layer is thus compacted before the succeeding layers are deposited. Each layer shall not exceed 200mm in thickness.

10.9.2.5 Sand filling in plinth and other places

At places back filling shall be carried out with local sand if directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

10.9.2.6 Filling in trenches

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

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

In case of excavation of trenches in rock, the filling upto a level 30cm above the top of the pipe shall be done with fine materials, such as earth, murrum etc. The filling up of the level of the centerline of the pipe shall be done by hand compaction in layers not exceeding 8cm, whereas the filling

above the centerline of the pipe shall be done by hand compaction or approved means in layers not exceeding 15cm. The filling from a level 30cm above the top of the pipe to the top of the trench shall be done or other approved mechanical methods with broken rock filling of size not exceeding 15cm mixed with fine material as available to fill up the voids.

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

10.9.2.7 Soil fill

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

Where density of fill or use of rollers is not specified the fill shall be carried out as specified in Clause 10.9.2.4 above.

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

10.9.2.8 General Site Grading

Site grading shall be carried out as indicated in the approved drawings and as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified herein unless otherwise indicated below:

If no compaction is called for, the fill may be deposited to the full height in one operation and leveled. If the fill has to be compacted, it shall be placed in layers not exceeding 225mm and leveled uniformly and compacted as indicated in Clause 10.9.2 before the next layer is deposited.

To ensure that the fill has been compacted as specified, the Contractor at his cost shall carry out field and laboratory tests.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If specifically permitted by the Engineer, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the Contractor to demonstrate that the desired / specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

If so directed by the Engineer, the rock as obtained from excavation may be used for filling and leveling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above, has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc., and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100mm thick mixed layer of broken material and earth shall be laid and consolidated carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

10.9.2.9 Fill Density

The compaction, where so called for, shall comply with the specified (Standard Protector / Modified Protector) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

10.10 Dewatering

All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.

10.11 Blasting in Hard Rock

10.11.1 General Requirement

Unless otherwise stated herein, IS specification "IS 4081": Safety code of Blasting and related Drilling Operations" shall be followed. After removal

of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profile as are shown on the drawings or such other lines and grades as may be specified by Engineer. At all stages of excavation precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosives used shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by Engineer, the rock shall be removed by wedging, pick, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

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

In no case shall blasting be allowed close than 30 mtrs to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old. As far as is possible, all blasting shall be completed prior to laying concrete for any foundations or any other purposes. Permission for blasting maybe refused, at the discretion of the Engineer, after casting of foundations is started, in which case excavation in hard rock shall be done by other methods.

10.11.2 Specific Requirements

For blasting operations, the following points shall be observed:

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

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

Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200m, radius from the firing point, at least 5 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.

The blasting of rock near any existing buildings, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done with small charges only and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.

The firing shall be supervised by a Supervisor and not more than 6 (6) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

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

Contractor shall preferably detonate the explosives electrically.

The explosives shall be exploded by means of a primer, which shall be fired by detonating a fuse instantaneous detonator (FID) or other approved cables. The detonators with FID shall be connected by special nippers.

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

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

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75mm shall be filled up as instructed by Engineer, with concrete of strength not less than M15. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for.

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

10.12

Line drilling and Pre-shearing

Line drilling and pre-shearing in rock shall be resorted when so specified or directed by the Engineer. This technique shall be used when the excavation in rock (hard and stratified) has to be carried out to exact lines and levels and when absolutely no over excavation is permissible. It shall also be used where rock blasting is required to be carried out in the close proximity of existing structures, equipment etc.

This technique consists of drilling holes, as close as warranted by the rock conditions and to such depth as may be necessary, along the periphery (or line) of the area within which excavation has to be carried out. This will ensure that when rock inside the area is blasted, over excavation / over break damage to adjoining property is avoided as the rock shears off along the line of drilled holes.

The diameter, depth and spacing of holes, shall be decided by the Engineer or as specified in the drawings / schedules. The holes shall be generally be 48mm in diameter. The Engineer may direct a second line or subsequent lines of holes to be drilled in addition at suitable location/s to facilitate safe excavation.

The layout of the interior blasting holes shall be carefully planned. Only light blasting is permitted in the interior holes, which are close to the line drilled holes.

The Contractor shall have to carry out tests to determine the amount of explosives required to ensure an even break at the line drilled holes, so that damage to structure outside line drilled holes as also over breaks are avoided.

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After the interior holes are blasted any irregularities in the vertical line drilled face, which was line drilled, shall be removed and trimmed by wedging, splitting, chiseling and barring.

Excavation shall generally be carried from the centre to the outside.

The Engineer may direct a trench to be cut between adjacent line drilled holes. In such a case, rock between line drilled holes shall be blasted with such pattern of holes as will not cause any damage to any structure close by and also not shatter or render unsuitable any good rock outside the line drilled holes.

Line drilling and pre-shearing will only be permitted in hard rock.

10.13

Setting of stubs

The stub shall be set correctly in accordance with approved method at the exact location and alignment and in precisely correct levels. Stubs shall be set in the presence of the Engineer's representative available at site for which adequate intimation shall be given to the Engineer by the Contractor.

The placing of the stubs shall be within the tolerances specified below:

- a) The difference in elevation between identical parts of any two stubs shall not exceed $1/1000$ of the horizontal distance between the stubs, allowance being made for the difference, if any, in the lengths of legs. The actual elevation of any stub shall not differ from the prescribed elevation by more than 6mm of its correct position.
- b) The difference in horizontal spacing from specified distance between identical parts of any two stubs shall not exceed $1/1000$ of the horizontal distance between the stubs.

The Engineer's representatives shall approve setting of stub at each location. The approval shall not, however, absolve the Contractor of his responsibility of correct setting of stubs and casting of foundations, who will be required to rectify the faulty work at his own expenses.

The Engineer reserves the right to uncover the foundations subject to total maximum of 25% locations and if any foundation is found faulty, the Contractor shall be required to uncover all foundations as demanded by the Engineer / Owner and bear all the expenses there of as well as the expenses of rectifying all inadequate or faulty foundations thereby disclosed and putting all these back in order.

10.14

Concrete

All cement to be used shall be Portland cement meeting the requirements of the relevant Indian Standards (mainly IS 269), from an approved manufacturer. Cement shall be adequately protected from moisture or contamination during transportation and storage at site. Cement in bags shall be limited within a heap of 13 bags in store and 7 bags at site. No cement containing lumps or deleterious matter shall be used.

The concrete used for the foundation shall be M20 grade (i.e., of 20N/mm^2 cube compression strength at the end of 28 days), with 20mm down graded stone metal for walls and other members less than 600mm thickness and 40mm down graded stone metal for thicker members of the works including pyramid portions. Aggregates shall conform to specifications for coarse and fine aggregates from natural sources for concrete as per IS 383. The methods used for the preparation of concrete and all its properties regarding strength under compression, tension, shears, punching and bending etc., as well as workmanship shall conform to the relevant Indian Standard codes of practice.

The sand used for the concrete shall be composed of hard siliceous materials. It shall be clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts and screened through a mesh not more than 5mm in the clear.

The aggregates shall be of clean broken hard granite or other stone specified or approved by the Engineer. It shall be of hard, closed-grained quality. It shall also be as far as possible cube like, preferably angular, but not flaky, perfectly clean and free from earth, organic or other deleterious matters. 40mm aggregate shall be of size as will pass through a mesh of 40mm measured in clear. All fine and coarse aggregates shall be obtained from sources approved by the Engineer.

The water used for mixing concrete shall be fresh clean and free from oil, acid and alkali organic materials or other deleterious substances. Salty or brackish water should not be used. Potable water is generally satisfactory.

Though not generally expected, sulphate-resisting cement may be necessary if so indicated during soil investigation. Sulphate-resisting cement shall be in accordance with IS standards and shall be obtained from a source approved by the Engineer. The Engineer shall decide the locations where it shall be mandatory for the Contractor to use sulphate-resisting cement. The Contractor shall certify that the proposed cement is of the required quality regarding resistance to corrosion due to sulphates. Methods of testing this quality shall be deemed to have been included in the rates quoted. The use of aluminous cements will not be permitted.

10.14.1 Batching and Mixing of Concrete

It shall be Contractor's responsibility to carry out tests on samples for concrete mix design that the Contractor proposes to employ in foundation

concrete as per relevant clauses of IS 456. The test result of the proposed mixture together with data for water cement ratio and slump shall be submitted to the Engineer for approval at least four (4) weeks before the commencement of concreting operation.

The Contractor shall be responsible for maintaining the mix, control and testing of concrete throughout the working period. Neither the mix proportions nor the source of the supply of materials shall be altered without the prior approval of the Engineer.

The minimum cement content, the water cement ratio, the slump and all other characteristics of concrete shall be demonstrated to conform to the relevant Indian Standards.

The concrete shall be mixed with an approved concrete mixer. In no case shall hand mixing be allowed. The Contractor shall provide the measuring equipment and shall maintain and operate the equipment as required to accurately determine and control the amount of each separate ingredient entering the concrete. The equipment shall be constantly maintained in first-class workable conditions during the working period. The concrete mixing shall be cleaned and inspected at suitable intervals in the presence of the Engineer.

Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional cement to allow for stickling in the drum.

The cost of all concrete testing shall be deemed to be included in the price of the concrete works. In addition, the Engineer shall retain the right to undertake slump tests at any time prior to the placement of concrete and reject any batch of concrete that fails such tests, all at the cost of the contractor.

Mixing shall be continued until there is uniform distribution of material and the mix is uniform in color and consistency but in no case the mixing is done for less than 2 minutes. Normally mixing shall be done close to the foundation. The concrete shall be placed and compacted before setting commences.

The concrete should be mixed as stiff as the requirement of placing the concrete in the forms or moulds with ease and the degree to which the concrete resists segregation. Hence, the quantity of water used should not be too much. Concrete shall not be directed poured from a height more than 1.5 m to avoid mix segregation.

Formwork shall conform to the provisions of Clause 11 "Formwork" IS 456. Proper forms or moulds adequately braced to retain proper shape while concreting should be used. The mould should be water tight so that cement cream should not come out leaving only sand and jelly

consequently forming of honeycombing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.

The stub shall be free of rust and cleaned thoroughly and painted with cement paste, made of 1 part of cement and $\frac{3}{4}$ part of water (cement slurry) to a thickness of 1.6mm before the concrete is laid against the stub. The painting with cement slurry shall be done each time such a height before the cement wash becomes dry.

Concrete shall, in all cases be placed in the presence of the Engineer. No concrete shall be placed until the Engineer has approved the excavated surface, stub setting, and inspection of formwork and completion of all preparation work. Adequate chutes or other approved method shall be employed to place concrete. All concrete shall be consolidated to the maximum practicable density with a concrete vibrator and surface made smooth and free from pockets and honeycomb.

The concrete shall be laid in 150mm layers and consolidated well so that the cement cream works up to the top and no honeycombing are left in the concrete. Concreting is to be done continuously so that the subsequent layers are laid before the final setting of the bottom layer begins.

If fresh concrete is to be laid on old concrete less than a week old, the surface of the old set concrete should be chipped and cleaned thoroughly with wire brush and washed with a layer of thick cement slurry before the new concrete is laid. If, however, the concrete is more than 10 days old, the top layer of the set concrete should be chipped and cleaned thoroughly with wire brush and water and layer of cement mortar (1:2) 12mm thick shall be laid evenly after giving a coat of cement slurry, as specified above to ensure proper bonding between old and new concrete. If a foundation / chimney or any other concrete member is damaged during the course of the works, it shall be brought to the notice of the Engineer, and rectified as directed by him.

After concreting the chimney portion to the required height, the top surface should be finished smooth, with slight slope towards the outer edge to drain off the rainwater falling on the coping.

In wet locations, the site must be kept completely de-watered both during the placing of the concrete and 24 hours after completion. There should be no disturbance of concrete by water during this period.

The forms or mold shall not be removed before a lapse of about 24 hours after the completion of concreting. After removal of the forms, the concrete surface, where required shall be repaired with a rich cement and sand mortar in the shortest possible time.

For concreting during hot weather adequate provision shall be made to lower concrete temperature which shall not increase beyond 40°C at the time of placement of fresh concrete.

All exposed concrete and structure steel within one meter of the ground or high water level, whichever is higher, shall be painted with a black bituminous paint, Flintcote or approved type, before handing over the switchyard to the Owner.

10.14.2 Concreting in Cold Weather

When there is danger of freezing, certain minimum temperatures and concrete, as placed, are specific because much of the heat generated during hydration of cement is not immediately available.

The temperature of the concrete shall not be less than 4.5°C in moderate weather or 10°C when the mean daily temperature drops below 4.5°C.

To obtain the required temperature for freshly mixed concrete in cold weather, it is necessary to heat mixing water or aggregates, or both, depending on severity of the weather. Heating of the mixing water is the most practicable and efficient procedure. The minimum temperature at which water and the aggregates should enter the mixer, to produce 15°C temperature of concrete shall be 60°C and 3.5°C respectively. Fluctuations in temperature from batch to batch shall be avoided. Very hot water should not be allowed to touch the cement because of the danger of causing quick or "flash" set. If hot water and the coldest portion of the aggregate can be brought together in the mixer first so that the temperature of this mixtures does not exceed about 38°C the possibility of flash set will be minimized.

The aggregates should be heated uniformly and carefully eliminating all frozen lumps, ice and now, and avoiding overheating or excessive drying. Average temperatures should not exceed 62°C and maximum temperatures should not exceed 100°C.

Heating of aggregates is preferably accomplished by hot water.

Concrete shall be protected against freezing temperatures for at least 48 hours after being placed when the mean daily temperature is 4.5°C or above. When the mean daily temperature is below 4.5°C concrete as placed should have a temperature of not less than 10°C and should be maintained at the same temperature for at least 72 hours.

Heat of hydration can be gainfully conserved by having insulating formwork covers of timber, clean straw blanket sacking, tarpaulins, plastic sheets etc., in conjunction with air gap upto first 3 days even when ambient temperatures are lower.

For moderately cold weather timber formwork alone is sufficient and is preferable to steel formwork.

When the concrete is cured by membrane curing no additional protection against freezing is required if the protection at 10°C for 72 hours is obtained by means of adequate insulation in contact with the forms or concrete surfaces. If membrane cured concrete is not protected by insulation, the concrete should be protected against freezing temperatures for an additional 72 hours immediately following the 72 hours of protection at 10°C. Water cured concrete must be protected against freezing temperatures for 3 days immediately following the 72 hours protection at 10°C.

Protection required in cold weather is only as much necessary as to keep the temperature of the concrete from falling below specified temperature during certain initial periods. The most common method of protection is to enclose the structure and surround it with atmosphere warm enough to maintain the required temperatures.

Enclosures should be tight and windproof. Stoves of various types may be used for heating. These are easy to handle, inexpensive and are convenient for small jobs but they have the disadvantages of producing dry heat. Dry heat for protection of concrete in cold weather tends to produce rapid drying because warm air will hold much more moisture than cold air. It is important, therefore, that the concrete be supplied with adequate moisture when dry heat is used.

Because of slower rate of gain of strength during cold weather, the formwork & props have to be kept in place for longer than in usual concreting practice. The appropriate time of removal of formwork may be 5 days for chimney.

10.14.3

Curing

The concrete after it is 24 hours old shall be cured by keeping concrete wet continuously for a period of 10 days after laying. The pit may be backfilled with selected earth, sprinkled with necessary amount of water and well consolidation in layers not exceeding 150mm of consolidated thickness after a minimum period of 24 hours and thereafter both the back-filled earth and chimney top shall be kept wet for the remainder of the prescribed period of 10 days. The uncovered concrete member above the backfilled earth shall be kept wet by providing empty cloth or Hessian bags dipped in water fully wrapped around the concrete member of curing and ensuring that the bags are kept wet by frequent pouring of water on them.

10.14.4

Repair and Replacement of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form-holes, etc., shall be brought to the notice of the Engineer who may permit the patching of the defective areas or reject the concrete work. Rejected concrete shall be removed and replaced by the Contractor without any additional expense to the Owner. After removing loose materials, the surface shall be prepared and saturated with water for 24 hours before patching is done with 1:1 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by the Engineer.

10.15

Reinforcement

All materials, activities and methods regarding reinforcing steel shall conform to the relevant IS codes, particularly to IS 432 for mild steel bars and wires, IS 1786 for High Strength bars and wires and IS 1566 for steel wire fabric. The Contractor shall provide certificates stating origin and process of manufacture of reinforcing steel and submit test certificates from supplier to the Engineer. At the discretion of the Engineer, samples of reinforcing steel selected by the Engineer shall be tested by the Contractor at a local laboratory of the Engineer's choice, to demonstrate the tensile strength of the steel. The cost of such testing shall be deemed to be included in the Contractor's rates.

The wire shall be 1.25mm in diameter or heavier black annealed iron wire. Preformed clips or attachments shall be of proper design and strength so that reinforcing bars are rigidly supported/held in position, and are not capable of movement during concrete pouring.

Reinforcing steel shall be protected from damage during transportation and during storage. It shall be stacked horizontally with adequate supports to prevent distortion. Bars of different lengths and diameters shall be stacked separately and marked for easy identification.

Reinforcing steel shall be cold bent without any application of heat, by a slow and regular movement. Bending shall be done accurately to dimensions given in the bar bending schedule or foundation drawings in accordance with IS 2502.

Bars having cracks or splits on the bends shall be rejected.

Immediately before placing concrete, it shall be ensured that reinforcing steel is free from dirt, detrimental scale, paint, mortar, oil, or other foreign substances.

Reinforcing steel embedded or partially embedded in the concrete shall remain completely undisturbed for a minimum period of 24 hours, or longer if the Engineer so directs, after a unit of concrete placement has been completed.

Steel shall be placed accurately in accordance with the Drawings. It shall be tied securely at each intersection. Metal or concrete chairs and metal spreaders of approved types shall be used where necessary for support or spacing of steel bars.

Wood supports or spreaders shall not be used.

Splicing of bars except where shown on the drawings shall not be permitted without the prior written consent of the Engineer. Bar splicing shall be by overlapping, as indicated on the Drawings and the lap lengths shall not be less than 52 times the diameter of the smaller bar.

10.16 RCC Building Works and Liquid Retaining Structures

Apart from the different codes, design criteria mentioned elsewhere following codes and design criteria also to be followed for design of RCC buildings and liquid retaining structures.

Minimum grade of concrete for RCC building works shall be M20 and that for and liquid retaining structures shall be M25.

The minimum size of structural components shall be as follows:

- a. Slab: 125 mm
- b. Beam: 230mm x 230mm
- c. Column: 230mm X 230mm
- d. Wall thickness: 150mm
- e. Raft slab: 200mm

The minimum clear cover to reinforcement shall be as follows:

- a. Roof slab: 25mm (top & bottom)
- b. Raft slab: 50mm (top & bottom)
- c. Beam: 40mm (All around)
- d. Column: 40mm (All around)
- e. Wall: 40mm

10.16.1 Permissible Stresses

For concrete structures, other than liquid-retaining structures, permissible stresses shall be as per IS:456.

For liquid-retaining structures, the permissible stresses shall be according to BS 8007 (Design of Concrete Structures for Retaining Aqueous Liquids). Alternatively, the design may be based on requirements of IS:456, with crack width limited to 0.1mm.

10.16.2 Loads

The structures are designed for the following loads:

10.16.2.1 Dead Loads, Live Loads and Wind Loads

These shall be as per IS:875.

10.16.2.2 Seismic Loads

Seismic loads shall be considered according to IS:1893.

10.16.2.3 Combination of Load Cases

A judicious combination of the loads specified above keeping in view the probability of their simultaneous occurrence and their disposition in relation to other and severity of stresses or deformations caused due to the various loads is necessary to ensure the required safety and economy in the design of a structure.

10.16.3 Retaining Walls

Retaining walls are expected to be erected, partly along the boundary of the switchyard, or at locations, for instance on slopes, where there are chances of soil erosion due to rainwater, etc. The wall shall be a random rubble masonry wall in 1:5 cement mortar with provision of necessary weep holes and filters. The walls shall be finally pointed in 1:3 cement mortar. Alternatively, RC retaining wall may also be permitted. The designs shall be finally pointed in 1:3 cement mortar. Alternatively, RC retaining wall may also be permitted. The design shall be developed by the Contractor and approved by the Engineer.

The various Factors of Safety for stability checks of all types of retaining walls shall be as follows:

Overturning – Dead & Live Loads and earth pressure with wind or earthquake	1.5
Overturning – Dead & Live Loads and earth pressure without wind or earthquake	2.0
Sliding - Dead & Live Loads and earth pressure with wind or earthquake	1.5
Sliding - Dead & Live Loads and earth pressure without wind or earthquake	1.75

All retaining walls greater than 6.0m in height shall be RCC walls, with counter forts. Apart from the provisions given in the relevant IS publications for gravity structures. IS:456 shall be used for the design of RC retaining walls, and IS 1905 shall be used for the design of Masonry Walls. Earth Quake load shall be taken as per IS:1893.

The filter medium for all walls shall consist of hand-packed stones, 50 to 75 mm in size, for a width of 600mm immediately behind the wall, from the top of the wall to a level at least 300mm below the lowest weep hole.

10.17 Erection of Steel Structures

10.17.1 Assembly of Support Structures

Structures shall be erected by member-by-member method on the foundations, not earlier than 14 days after concreting. The structures shall be erected in workman like manner and its members shall not be strained or bent during the course of erection. Care shall be taken to see that the jointing surfaces are clean and free from dirt or grit. The structure erection shall be done in strict accordance with the approved drawings. After initial erection, all structure bolts shall be checked to ascertain that all nuts are fully tight. The bolt threads shall be punched to avoid the nuts becoming loose.

Punching of bolts shall be made by chamfering the threads with center punch in at least three places equally spaced on the contact surface of bolts and nuts. The Contractor shall be entirely responsible for the correct erection of all structures as per the approved drawings and their correct setting on an alignment approved by the Engineer. If the stubs or superstructures after the erection are found to differ from approved drawing or to be out of alignment, the Contractor shall dismantle and re-erect them correctly at his own cost without extension of time. The structures must be truly vertical after erection and no straining will be permitted to bring them in alignment. Tolerance allowed for verticality will be 1 in 360 of structure height.

While erecting the structures following points shall be taken care of:

- a) Straining of the members shall not be permitted for bringing them into the position. However, if it is necessary to match hole positions at joints, tommy bars not more than 450mm long may be used.
- b) Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.
- c) All plan diagonals relevant to a section of structure shall be placed in position before assembly of upper section is taken up.

10.17.2 Tightening and Punching of Bolts and Nuts

All nuts shall be tightened properly using correct size spanners. Before tightening, it will be seen that filler washers and plates are placed in relevant gaps between members, and bolts of proper size and length are used with flat washers. The tightening shall progressively be carried out

from the top downwards, with a care being taken that all bolts at every level are tightened simultaneously.

The threads of bolts projecting outside the nuts shall be punched at three positions on the diameters to ensure that the nuts are not loosened in course of time. If during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

10.17.3 Final Checking

After completion of the Works, final checking of the structure shall be done by the Contractor to ensure that all the foundation works, structure / tower erection and stringing have been done strictly according to the specifications and approved by the Supervising Engineer. All the works shall be thoroughly inspected keeping in view the following points:

- Sufficient backfilled earth is lying over each foundation pit and it is adequately compacted.
- Concrete pedestals and their coping are in good finely shaped condition, painted as per the specifications.
- All the structure members are correctly used, strictly according to final approved drawings and free of any defect or damage whatsoever.
- All nuts are properly tightened and the threads punched.

10.18 Cable Trench

The detailed design of cable trench shall be the responsibility of the Contractor. All designs and details shall be subjected to the approval of the Engineer. Indicative drawing is enclosed showing salient details of trenches. The Contractor shall develop the final approved drawings there from. Design shall be carried out in accordance with the relevant clauses of IS:456. Surcharge to be considered shall be 500 kg/m². Cable tray load shall be 120 kg/m of cable run for 650 mm wide supporting racks and 50 kg/m of cable run for 300 mm wide supporting racks. Each support angle member is also designed for 75 kg (weight of a person) as concentrated load.

10.18.1 Type of Cable Trench

Cable trench shall be of reinforced concrete. The outdoor cable trench covers shall be RC precast covers and those inside the control building shall be steel chequered plate covers. Covers shall have facility for lifting. Minimum concrete grade for cable trenches and precast covers shall be M20. The reinforced concrete, cast iron or heavy duty PVC pipe of minimum 150mm diameter shall be installed in the cable trench sump pit to the nearest drainage sump to drain the water in the cable trench.

10.18.2 Conduit and Hand Holes

The Contractor shall provide the conduit and hand hole for the cable from the main trench to the steel structure or equipment foundation. The hand hole shall be reinforced concrete with galvanized steel chequered plate cover. The size of the hand hole shall be large enough to pull the cable from the conduit to the foundation and minimum size of hand hole shall be 0.50m x 0.50m. The conduit shall be asbestos cement drainpipe. The diameter of the Conduit shall be 0.16m

10.18.3

~~Gravel Pack~~

The gravel pack used shall be of size 6mm to 10mm well graded. The gravel shall be rounded edges and no sharp corners will be permitted. Gravelling will be done right from the bottom of the hole.

10.19

Breaking of Concrete, Brickwork, Block work and Stone Masonry

The Contractor shall demolish any brickwork, block work, stone masonry or concrete, either plain or reinforced, as may be required. The waste material shall be removed from the location and dumped at suitable location or transported and disposed off as directed by the Engineer. The Contractor shall observe all precautions by way of necessary propping, strutting etc., to the satisfaction of the Engineer to ensure that adjacent framework is not damaged. Any damage to the adjacent framework, brickwork or block work resulting from negligence of the Contractor thereof shall be made good at the Contractor's cost to the satisfaction of the Engineer.

10.20

Inspection and Testing

10.20.1

General

Unless the Approved Make / Manufacturer is specifically spelt out, procurement of all items shall be made only after intimation and approval of the source by the Owner / Engineer.

All material supplied by the Contractor, whether as procured (steel, cement, aggregates, reinforcement etc), or in finished form (concrete, galvanized fabricated steel members etc), shall be subject to testing to approval of Engineer / Owner as per the relevant IS code governing that material, at any stage during the execution of the Contract, from procurement upto commissioning and handing over of the plant to the Owner, the cost of which shall be borne by the Contractor.

Apart from the tests specified in the relevant IS codes, those specified herein below and others mentioned in the specifications of individual components of the works shall also be performed to the satisfaction of the Engineer, the cost of which shall be borne by the Contractor.

The Contractor's entire establishments, whether for manufacture or for storage of material, will be inspected by the Engineer during the tenure of the Contract. Every facility shall be provided by the Contractor to enable the Engineer to carry out the necessary inspection of the establishment and the cost of all tests during manufacture and preparation of tests records shall be borne by the Contractor. The dispatch clearance will be issued to the Contractor by the Owner, on receipt of concurrence from the Engineer.

The materials shall be inspected and tested during manufacture by an approved inspection firm or laboratory and be accompanied by appropriate compliance certification as part of the extent of works. The Owner / Engineer may also inspect and test raw and finished materials from time to time at any independent laboratory of his own choice, independently of the Contractor. All expenses related to such testing including transport of the material to the laboratory, testing charges, inspection / supervision of the tests by the Owner/Engineer should be the Contractor's account.

It is the responsibility of the Contractor to advise the Engineer that the materials shall be available for inspection.

The passing of such inspection or test will not, however, prejudice the right of the Engineer to reject at a later date, the plant and any or all of material, if it does not comply with the specifications, or give complete satisfaction in service.

Instruments shall be approved and shall, if required by the Engineer, be calibrated by the National Physical Laboratory or such other body as may be approved, at the expense of the Contractor.

Unless otherwise specified in this Contract, selection of test samples, numbers of specimens and acceptance of results shall be in accordance with the terms of the relevant Indian Standards, where applicable. Where no terms exist, the Engineer is to instruct details in advance of the inspection and tests in response to the request of the Contractor.

The following tests, apart from those specified in the relevant IS codes, shall be carried out at the manufacturer's works.

10.20.2 Structural steel Material Test

Steel material used for supporting steel structures shall be subjected to tensile load or bend test in accordance with the Indian Standards. Test shall be performed by the Contractor without any additional cost. The test specimens shall consist of members selected randomly by the Engineer from any of the structures selected by him for the purpose of testing, whether erected or not the Engineer reserves the right, if the situation so

warrants, to get tested at Contractor's expenses 5% by weight of the steel used for support structures.

10.20.3 Concrete Tests

The Contractor shall carry out tests on sample of concrete from the foundation and other concrete works, as required by the Engineer.

The test specimens shall be cubes of 150mm side and the mould shall be of metal with inner face accurately machined. Each mould shall be provided with a metal base having a smooth machined surface. The interior surfaces of the mould and base shall be lightly oiled before concrete is placed in the mould.

Test specimens shall be molded by placing the fresh concrete in the mould in 50mm layers, each layer being thoroughly compacted with a steel bar 380mm long and having a ramming face 25mm square and weighing 2.8 kg. The concrete may be compacted by vibration, each layer being vibrated by means of an electric or pneumatic hammer or by means of a suitable vibrating table.

Concrete for test specimens shall be taken at the point of deposit. To ensure that the specimens are representative of the concrete in the foundations a number of samples shall be taken from different points. Each sample shall be large enough to make one test specimen and shall be taken from one point in the work.

The test specimens shall be stored at the site at a place free from vibration, under damp sacks for 24 hours, plus ½ hour, after which time they should be removed from the moulds, marked and stored in water at a temperature between 10°C and 21°C until the test date. Specimens that are to be sent to a laboratory for testing shall be packed for transit in damp sand, or other suitable damp material, and shall reach the laboratory at least 24 hours before test. On arrival at the laboratory, they shall be similarly stored in water until the date of the test.

The test shall be made at the age of the concrete corresponding to that for which the strengths are specified. Compression test shall be made between smooth plane steel plates without end packing and a load shall be applied axially at the rate of approximately 13.8 N/mm² per minute. One compression plate of the testing machine shall be provided above seating in the form of a proportion of a sphere, the center of which coincides with the central point of the face of the plate. Test specimens shall be placed in the machine in such a manner that the load is applied to the sides of the specimens as cast.

The results shall be handed in triplicate to the Engineer, as soon as possible after testing.

10.20.4 Measurement of Galvanizing Thickness

The Contractor shall have available on site for the Engineer's use, an instrument suitable for the accurate checking of galvanizing thickness. The gauge shall be available from the time of arrival of the first consignment of steelwork until the issue of the taking over certificate for the last line. The cost of the gauge and other operating expenses shall be deemed to be included in the Contract Price and the gauge shall remain the property of the Contractor.

Other tests on galvanizing shall be carried out as described in Clause 10.5.8 "Galvanizing".

10.20.5 Testing of Rock Anchors

Where rock anchor foundations are used in hard rock, as provided for by the Specification, the Contractor shall type test individual anchors by tensile test loading to failure. The type test shall be considered satisfactory if the foundation fails at or above the design ultimate strength of steel.

Anchor for type testing shall be installed away from permanent foundation anchors but in the same rock. The frequency of type testing shall depend upon the different types of hard rock encountered and the number of type tests performed shall be such as to give confidence in the employment of rock anchor foundations and experience of the type of rock suitable for their use.

The frequency of type testing shall, in the case of dispute, be reasonably determined by the Engineer.

The cost of rock anchor tests shall be borne by the Contractor.

10.21 General Building Works

10.21.1 Scope

This specification covers the general requirements for building works comprising brick and stone masonry, flooring, doors, windows, ventilators, wood/aluminium work, water-proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labor, materials and everything necessary for carrying out the work.

10.21.2 Applicable Codes and Specifications

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

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

IS:110	Ready mixed paint, brushing, grey filler, for enamel for use over primers.
IS:269	Specification for 33 grade ordinary Portland cement.
IS:280	Specification for mild steel wire for general engineering purposes.
IS:287	Recommendations for maximum permissible moisture content for timber used for different purposes.
IS:383	Specification for coarse and fine aggregates from natural sources for concrete.
IS:412	Expanded metal steel sheets for general purposes.
IS:428	Distemper, oil emulsion, color as required.
IS:702	Specification for industrial bitumen.
IS:710	Specification for marine plywood.
IS:712	Specification for building limes.
IS:733	Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes.
IS:777	Specification for timber paneled and glazed shutters (Part-1)
IS:1003	- DO - (Part-2)
IS:1038	Specification for steel doors, windows and ventilators.
IS:1077	Specification for common burnt clay building bricks.
IS:1081	Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.
IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
IS:1237	Specification for cement concrete flooring tiles.
IS:1322	Bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1361	Specification for steel windows for industrial buildings
IS:1397	Specification for Kraft paper.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:1477	Code of practice for painting of ferrous metals in buildings (Part-1).
IS:1477	- DO - (Part-2)
IS:1542	Specification for sand for plaster.
IS:1580	Specification for bituminous compounds for water proofing and caulking purposes.
IS:1597	Code of practice for construction of stone masonry: Part-1 Rubble stone masonry.

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

IS:3461	Specification for PVC asbestos floor tiles.
IS:3495	Method of test for burnt clay building bricks: Part 1 to 4.
IS:3536	Specification for ready mixed paint, brushing, wood primer, pink.
IS:3564	Specification for door closers (hydraulically regulated).
IS:3696	Safety code of scaffolds and ladders (Part-1)
IS:3696	- DO - (Part-2)
IS:4020	Methods of test for wooden flush door (Part 1 to 16)
IS:4021	Specification for timber door, window and ventilator frames.
IS:4351	Specification for steel door frames.
IS:4457	Specification for ceramic unglazed vitreous acid resisting tile.
IS:4631	Code of practice for laying epoxy resin floor toppings.
IS:4832	Specification for chemical resistant mortars (Part-2)
IS:4860	Specification for acid resistant bricks.
IS:4948	Specification for welded steel wire fabric for general use.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:5410	Cement paint, color as required.
IS:5411	Specification for plastic emulsion paint (Part-1)
IS:5411	- DO - (Part-2)
IS:5437	Wired and figured glass.
IS:5491	Code of practice for laying of in-situ granolithic concrete floor topping.
IS:6041	Code of practice for construction of autoclaved cellular concrete block masonry.
IS:6042	Code of practice for construction of light weight concrete block masonry.
IS:6248	Specification for metal rolling shutters and rolling grills.
IS:7193	Specification for glass fibre base coal tarpitch and bitumen felts.
IS:7452	Specification for hot rolled steel sections for doors, windows and ventilators.
IS:8042	Specification for white Portland cement.
IS:8543	Methods of testing plastics (Part 1/Section 1)
IS:9197	Specification for epoxy resin, hardeners and epoxy resin composites for floor topping.
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting.
IS:12200	Code of practice for provision of water-stops at transverse contraction joints in masonry and concrete dams.

10.21.3 Brick Work

10.21.3.1 Materials

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

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The nominal size of the modular brick shall be 200mm x 100mm x 100mm with the permissible tolerances over the actual size of 190mm x 90mm x 90mm as per IS:1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200mm and 100mm respectively. In the event of use of traditional bricks of nominal size 230mm x 115mm x 75mm with tolerance upto +3 mm in each dimension, one brick and half brick walls shall be considered as 230mm and 115mm respectively.

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

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

Sample bricks shall be submitted to the Engineer for approval and bricks supplied shall conform to approved samples. If demanded by Engineer, brick samples shall be got tested as per IS:3495 by Contractor at no extra cost to Owner. Bricks rejected by Engineer shall be removed from the site of works within 24 hours.

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

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the Engineer. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar, which is partially set,

shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The Contractor shall arrange for test on mortar samples, if so directed by the Engineer.

10.21.3.2 Workmanship

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

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

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not less than 6mm and nor more than 10mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering / pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the Engineer.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part-1). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering / painting.

In the event of usage of traditional bricks of size 230mm x 115mm x 75mm, the course at the top of the plinth and sills as well as at the top of the wall just below the roof / floor or slabs and at the top of the parapet shall be laid with bricks on edge.

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

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

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

RCC/Steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings duly finished on top with 2 layers of Kraft paper Grade 1 as per IS 1397 or 2 layers of 50 micron thick polyethylene sheets.

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

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

Necessary reinforced cement concrete transoms and mullions, of dimensions as indicated in the construction drawings prepared by Contractor and approved by Engineer, are generally required to be provided in the half brick partition walls.

When structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

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

Facing bricks shall be laid over 10mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

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

10.21.3.3 Uncoursed Random Rubble Masonry in Foundation, Plinth and Superstructure.

10.21.3.4 Materials

Stones for the works shall be of the specified variety, which are hard, durable, fine grained and uniform in color (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-1). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS:1124. The Contractor shall supply sample stones to the Engineer for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed. Cement-sand mortar for stones masonry works shall be in the proportion of 1:6 unless otherwise specified. Materials and preparation of mortar shall be as specified in clause 10.21.3.1.

10.21.3.5 Workmanship

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

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

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

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

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

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

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

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

Type of scaffolding to be used shall be as specified in Clause 10.21.3.2.

10.21.4 Coursed Rubble Masonry (First Sort) for Superstructure.

10.21.4.1 Materials

The material specification for the work shall be as per Clause 10.21.3.4.

10.21.4.2 Workmanship

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

Face stones shall tail into the work for not less than their height and at least $\frac{1}{3}$ rd the number of stones, shall tail into the work for a length not less than twice their height but not more than three-fourth the thickness of the wall, whichever is smaller. These should be laid as headers and stretchers alternatively to break joints by at least 75mm.

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

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

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

The requirement regarding through or bond stones shall be as specified in clause 10.21.3.5 with the further stipulation that these shall be provided at 1.5m to 1.8m apart clear in every course but staggered at alternate course.

The quoins, which shall be of the same height as the course in which they occur, shall not less than 450mm in any direction. Quoin stones shall be

laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100mm from the face. These stones shall have a minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per clause 10.21.3.2.

Requirements of execution of the work and curing shall be as stipulated in clause 10.21.3.5.

10.21.5 Concrete Block Masonry

10.21.5.1 Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS:2185 (Part-1)

Masonry units of hollow and solid light weight concrete blocks shall conform to the requirements of IS:2185 (Part-2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part-3).

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

The nominal dimensions of concrete block shall be as under:

Length: 400, 500 or 600mm

Height: 100 or 200mm

Width: 100 to 300mm in 50mm increments

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

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

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

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

The concrete mix for the hollow and solid concrete block/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume i.e., (1:6).

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

10.21.5.2 Workmanship

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

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

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

Concrete blocks shall be embedded with a mortar, which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in clause 10.21.3.1.

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

contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

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

As per the design requirements and to effectively control cracks in the masonry, RC bond beam/studs, joint reinforcement shall be provided at locations as per details indicated in the construction drawings prepared by Contractor and approved by the Engineer. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed bars as per the drawings.

For jambs of doors, windows and openings, solid concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete Grade M15. Hold fasts of doors/windows should be arranged so that they occur at block course level.

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

Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 10.21.3.2 shall be adopted for execution of block masonry work.

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

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

10.21.6 Damp-proof Course

Where specified, all the walls in a building shall be provided with damp-proof course to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even

under the door or other openings. Damp-proof course shall consist of 50mm thick cement concrete of M15 grade with approved waterproofing compound admixture conforming to IS:2645 in proportion as directed by the manufacturer. Concrete shall be with 10mm downgraded coarse aggregates.

The surface of brick/stone masonry work shall be leveled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

10.21.7 Miscellaneous Inserts, Bolts etc.

All the miscellaneous inserts such as bolts, pipes, plate embedment etc., shall be accurately installed in the building works at the correct locations and levels, all as detailed in the construction drawings. Contractor shall prepare and use templates for this purpose, if so directed by the Engineer. In the event, any of the inserts are improperly installed; Contractor shall make necessary arrangements at his own cost, to remove and re-install at the correct locations / levels, all as directed by the Engineer.

10.21.8 Wood Work in Doors, Windows, Ventilators & Partitions

10.21.8.1 Materials

Timber to be used shall be first class teak wood as per IS:4021. Timber shall be of the best quality and well seasoned by a suitable process before being planned to the required sizes. The maximum permissible moisture content shall be from 10% to 16% for timber 50mm and above in thickness and 9% to 14% of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform color and free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

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

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

Hardware of fittings and fixtures shall be of the best quality from approved manufacturers.

10.21.8.2 Workmanship

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

All works shall be executed as per the approved detailed drawings and/or as directed by the Engineer.

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

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

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

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

Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel,

ventian louver opening, teak wood lipping etc., shall be as indicated in the respective items of work. Panels of shutter shall be of marine plywood conforming to IS:710, if so specified. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS 4020, if so desired by the Engineer.

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

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidized or anodized aluminium shall be as specified. The number, size and type of the fittings and fixtures shall be as indicated in the approved drawings.

Woodwork shall not be provided with the finishes of painting, galvanizing etc., unless it has been approved by the Engineer. The type of finish and the number of coats shall be as stipulated. Preparation of the wood surface and application of the finishes shall be in accordance with clause 10.21.27.

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

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

Any carpentry work which show defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per specification requirements, at no extra cost to the Owner.

10.21.9 Aluminium Doors, Windows, Ventilators & Partitions

10.21.9.1 Materials

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

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

Hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

10.21.9.2 Workmanship

All aluminium doors, windows, ventilators and partitions shall be of the type as indicated in the approved drawings. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminium windows shall conform to IS:1949, if so specified.

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

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. tolerance in overall dimensions shall be within +1.5mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

Aluminium swing type doors, aluminium sliding windows, partitions shall be as per the approved drawings which indicate generally the arrangement along with the overall size of the various components and weight per running meter of the extruded sections to be adopted.

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

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

Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid

distortion and damage of the units. The dimensions of the masonry opening shall have 10mm clearance all-round the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames / glazing bars is prohibited.

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

Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gasket shall be provided for fixing the beads with concealed screws. The type of fixing the glazing shall be as indicated in the approved drawings.

The material, number, size and type of the hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidized or anodized aluminium shall be as per approved construction drawings.

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

Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the item of work. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

10.21.10

Steel Rolling Shutters

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

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

Shutters shall be built-up of interlocking laths 75mm width between rolling centers formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50 width and

notless than 1.20 mm for shutters above 3.50 width. Each lath section shall be continuous single piece without any welded joint.

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

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

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

All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conforming to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of work. Painting shall be carried out as per clause 10.21.28.

In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanized with a zinc coating containing not less than 97.5% pure zinc. The weight of the zinc coating per sq.m shall be as specified in the item of work.

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

10.21.11 Rubble sub-base

10.21.11.1 Materials

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS:1597 (Part-1).

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

10.21.11.2 Workmanship

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

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

10.21.12 Base Concrete

The thickness and grade of concrete and reinforcement shall be as per approved construction drawing.

Before placing the blinding concrete of M10 grade, 75mm thick, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

10.21.13 Terrazzo and Plain Cement Tiling Work

10.21.13.1 Materials

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

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

The aggregates for terrazzo topping shall consist of marble chips, which are hard, sound and dense. Cement to be used shall be either ordinary Portland cement or white cement with or without coloring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble power by weight. The proportion of cement shall be inclusive of any pigments. For every 1 part of cement-marble power binder mix, the proportion of aggregates shall be $1\frac{3}{4}$ parts by volume, if the chips are between 1mm to 6mm and $1\frac{1}{2}$ parts by volume if the chips are between 6mm to 25mm.

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

10.21.13.2 Workmanship

Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS:1443.

Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls / ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting / dado.

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

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

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

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

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

Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with beveled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish.

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

Contractor shall note that the unit rate quoted for skirting shall also include for any chipping of the brick work required to be carried out for this item.

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

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

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

10.21.14 In-Situ Terrazzo Work

10.21.14.1 Materials

The requirements of marble aggregates for terrazzo topping shall be as per clause 10.21.13.

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

10.21.14.2 Workmanship

The thickness, type, quality, size and color of chips etc., for the in-situ terrazzo finish for flooring / dado skirting shall be as per approved construction drawings. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS:2114.

In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The under layer shall be of cement concrete of mix M15 grade using 10mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30mm for flooring and 20mm for dado/skirting work.

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

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

Dividing strips shall be either of aluminium, brass or other material as per the approved construction drawings. Aluminium strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

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

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

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

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

10.21.15 Glazed Ceramic Tile Flooring, Dado and Skirting

10.21.15.1 Material

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

10.21.15.2 Workmanship

The size, thickness, color, with or without designs etc., of the tiles for flooring / dado / skirting shall be as specified.

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

The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modules of 1:5.

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

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

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

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

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

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

10.21.16 Indian Patent Stone Flooring

The Indian Patent Stone Flooring shall be 50mm in thickness and shall consist of cement concrete mixed in the proportion of 1:2:3 (with 12.5mm chips only) with an admixture of approved water proofing compound. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

It shall be laid after applying neat cement slurry to the surface in bays of suitable sizes but not exceeding 6 sq.m each and to required slope in a chess board alternate panel fashion and neatly finished smooth in red color where directed with lines drawn as directed. The concrete shall be cast against teakwood stop-off boards, which shall be removed only after the concrete is set.

No dry cement shall be allowed to be used for finishing the surface. Mechanical mixing may be resorted to.

The surface shall be kept well watered after it is dry for a period of 8 days.

Construction joints shall be formed in between the alternate panels cast, with straight edges, 20mm deep and 12mm wide in groove form. These joints on completion of work, shall be cleaned and washed free of dust with the help of brush and shall be treated with hot bitumen poured in the gap, over which fine sand shall be spread to arrest the flow of bitumen.

10.21.17 Floor Hardener Topping

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

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

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

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

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

10.21.18 Fully Vitrified Ceramic Floor Tiles

Fully vitrified tiles shall be 15mm thick at least equal to class 3 of IS:1478. Skirting tiles shall be supplied to match the floor tiles. Water absorption shall be less than 3% and hardness as measured by the Mohs' scale shall be greater than 6. The tiles shall resist acidic action and staining by oil, jointing material shall be acid resistant where shown.

Floors to be tiled shall be screeded to the levels shown on the drawings. Before the screed has fully hardened the surface shall be roughened by wire brushing or picking. An undercoat of 1:3 cement / sand mortar screed shall then be laid and bonded to the slab and immediately covered with a thin layer of 1:1 cement / sand slurry on which the tiles shall be laid and leveled. The joints shall, at the same time be carefully filled with cement grout and any surplus wiped off as the work proceeds. Care shall be taken to obtain a neat and uniform joint pattern.

After laying, the tiles shall be protected to the Engineer's approval and on completion of the works the tiles shall be thoroughly cleaned.

10.21.19 PVC Sheet / Tile Flooring

10.21.19.1 Material

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

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

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

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

The type, size, thickness, color, plain or mottled and the pattern shall be as specified.

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10.21.19.2 Workmanship

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

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

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

Layout of the PVC flooring shall be marked with guidelines on the underbed and PVC tiles / sheets shall be first laid for trial, without using the adhesive, according to the layout.

The adhesive shall be applied by using a notched trowel to the surface of the underbed and to the backside of PVC sheets / tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time, which can be covered with PVC flooring within the stipulated time.

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

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

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

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

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

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

10.21.20 Acid and/or Alkali Resistant Mortar for Flooring and Dao

10.21.20.1 Materials

The jointing the tiles shall be done with a self-hardening cement mortar specially designed to resist both acid and alkaline as well as mixed acid and alkaline conditions. For this purpose, a resin-type chemical resistant mortar shall be used comprising an intimate mixture of liquid resinous material and a powder composed of properly selected filler material and usually containing the setting agent. The material may be supplied in two components which when mixed at ordinary temperature shall form a trowelable mortar that subsequently hardens. The liquid resin may be either of a combination of the types like Phenolic Resin, Epoxy Resin and Polyester Resin. The filler materials, which are usually of a carbonaceous or siliceous nature shall be selected to have resistance particularly to hydrochloric acid and caustic soda. The catalyst material may be incorporated in the fillers in such a manner that it becomes effective when mixed with resin. For phenolic and furane resin mortars the resin and filler may be supplied in two packs. The resin shall have a viscosity that will permit it to be readily mixed with the powder by manual methods. The filler materials shall have properly graded particles that will permit the preparation of a minimum joint thickness of 1.5mm. "Furacin" as marketed by Coromandel Prodorite Pvt Ltd., containing furane resin or equivalent shall be used for this corrosion resisting cement. The mortar is to be prepared and applied strictly in accordance with instructions. If the material is supplied in two separate parts and inert powder and a resin based syrup, they must be mixed in the proportions given by manufacturer's data table.

10.21.20.2 Laying and Workmanship

The jointing shall be done for the full depth of the tile and the joint width shall be 3mm. The joints shall be finished smooth and flush pointed.

Mixing shall be carried out very thoroughly and carefully in a clean enameled dish or bowl. Any lumps in the powder must be broken down by careful mixing. Mixing should be carried out by adding powder to the syrup. The mixing shall be so arranged than the time specified by the manufacturer. At temperature 200C or above, the mixing pan and contents should be kept cool by immersion in water. All necessary measures should be taken so that the bulk masses of this resin based mortar, which generate heat in setting, are not allowed to remain under fairly warm conditions which may lead to a flash set. To avoid this, it is essential that the mixed mortar is spread a thin layer on a flat tray and not left in a mass. After jointing the tiles, the flooring should not be placed under service in normal conditions before eight days or as recommended by the manufacturer and depending on atmospheric temperature. During setting and hardening, no water, steam or acid should come in contact with this jointing mortar.

If the flooring has to be sloped the same shall be provided in the concrete slab or an additional graded underbed shall be provided if required, with cement sand mortar (1:3) by volume.

The Contractor shall furnish full details regarding the materials for the different treatments described above pertaining to this flooring work as per manufacturer's specifications, and shall lay setting mortar and set the tiles properly in full conformation with the manufacturer's instructions. The entire work shall be done in workmanlike manner to the complete satisfaction of the Engineer.

10.21.21 Preformed Filters and Joint Sealing Compound

10.21.21.1 Materials

Preformed filler for expansion / isolation joints shall be non-extruding and resilient type of bitumen impregnated fibre conforming to IS:1838 (Part-1).

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

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS:1834.

10.21.21.2 Workmanship

The thickness of the preformed bitumen filler shall be as specified in the respective items of work. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces / thicknesses of strips to make up the specified size shall not be permitted.

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

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

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

10.21.22 Cement Plastering Work

10.21.22.1 Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) unless otherwise specified under the respective item of work. Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. The quality and grading of sand for plastering shall conform to IS:1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer. If so desired by the Engineer sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

10.21.22.2 Workmanship

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

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

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

Interior plain faced plaster:

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

Plain faced ceiling plaster

This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated for interior plain faced plaster.

Exterior plain faced plaster

This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated for interior plain faced plaster except finishing is to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 6mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item work. The finished plastering work shall be cured for at least 7 days.

Interior plain faced plaster

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

Exterior sand faced plaster

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

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

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

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

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

When the specification items of work calls for waterproofing plaster the Contractor shall provide the waterproofing compound as specified while preparing the cement mortar. Payment for waterproofing compound will be made separately if it is not included as a combined item of work.

Where lath plastering is specified, it shall be paid for at the same rate as for plaster work except that separate payment for metal lath will be made.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or

to natural breaking points like doors / windows etc. Ceiling plaster shall be completely first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 10.21.3.2.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

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

Plastering work shall be deferred as much as possible, so that fairly complete drying shrinkage in concrete and masonry works takes place.

Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage / thermal movement.

Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

10.21.23 Cement Pointing

10.21.23.1 Materials

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

10.21.23.2 Workmanship

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

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

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever colored pointing is to be done, the coloring pigment of the color required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer.

10.21.24 Metal Lath and Wire Fabric

10.21.24.1 Materials

Welded steel wire fabric shall conform to IS:4948.
Expanded metal shall conform to IS:4112
Galvanized wire mesh shall be of approved quality.

10.21.24.2 Workmanship

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

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

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

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

10.21.25 Waterproofing Admixture

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

10.21.26 Painting of Concrete Masonry and Plastered Surfaces

10.21.26.1 Material

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

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

Acrylic emulsion paint shall be of an approved manufacture.

Plastic emulsion paint shall conform to IS:5411.

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

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

Color wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer.

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

10.21.26.2 Workmanship

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

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

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

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

White Wash

The prepared surfaces shall be wetted and the finish applied by brushing. The operation of each coat shall consist of a stroke of the brush first given

horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified in the item of work. The dry surface shall present a uniform finish without any brush marks.

Color Wash

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

Cement Paint

The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coat shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water-proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same color shall be applied unless otherwise specified in the item of work. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for at least 2 days after the application of final coat. The operations for brushing each coat shall be as detailed under White Wash above.

Oil Bound Distemper

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

10.21.27

Painting & Polishing of Wood Work

10.21.27.1 Materials

Wood primer shall conform to IS:3536.
Filler shall conform to IS:110.
Varnish shall conform to IS:337.
French polish shall conform to IS:348.
Synthetic enamel paint shall conform to IS:2932.

All the materials shall be of the best quality from an approved manufacturer, Contractor shall obtain prior approval of the Engineer for the brand of manufacture and the color / shade. All materials shall be brought to the site of works in sealed containers.

10.21.27.2 Workmanship

The type of finish to be provided for woodwork of either painting or polishing, the number of coats, etc., shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid, cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS:2338 (Part-1).

All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work. Any slight irregularities of the surface shall then be made up by applying an optimum coat of filler conforming to IS:110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Engineer. The number of coats of paint to be applied shall be as specified.

All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign mater. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off.

10.21.28 Painting of Steel Work

10.21.28.1 Materials

Red oxide – Zinc chrome primer shall conform to IS:2074
Synthetic enamel paint shall conform to IS:2932.
Aluminium paint shall conform to IS:2339.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the Engineer for the brand of manufacture and the color/shade. All the materials shall be brought to the site in sealed containers.

10.21.28.2 Workmanship

Painting work shall be carried out only on thoroughly dry surface. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS:1477 (Part-2).

The type of paint, number of coats etc., shall be as specified in the respective items of work.

Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS:1477 (Part-1) and as specified.

It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without 'holiday'. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'.

After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing and allowed to hard dry. The gloss from the entire surface shall then be gently removed

and the surface dusted off. The second finishing coat shall then be applied by brushing.

At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Engineer.

10.21.29 Flashing

10.21.29.1 Materials

Anodized aluminium sheets shall be 1mm thick with anodic film thickness of 0.025mm.

Galvanized mild steel sheets shall be 1mm thick with zinc coating of 800gms/sq.m

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

10.21.29.2 Workmanship

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

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

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

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

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

10.21.30 False or Cavity Floor

10.21.30.1 Scope

This specification covers the requirements of false or cavity floor constructed over reinforced concrete floor slabs for control rooms, computer rooms and other similar structures.

10.21.30.2 Frame Work

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

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

10.21.30.3 Floor Panels

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

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

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

The particle boards shall be faced with 600mm x 600mm x 2mm thick approved make flooring tiles conforming to IS:3462 – "Specification for Unbacked Flexible PVC Flooring" and of approved color and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the supporting framework. Each

floor panel shall be marked on the inner side with stickers for easy identification and reassembly wherever required.

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

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

10.21.30.4 Ramps And Steps

Ramps and steps shall be provided as specified.

10.21.30.5 Imposed Loading

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

10.21.30.6 Finish

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

10.21.30.7 Contractor Drawing

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

10.21.30.8 Guarantee

Contractor shall give one (1) year guarantee, in format approved by Owner / Engineer, against any defects caused by faulty materials and or workmanship or non-compliance with this specification.

10.21.30.9 Alternative specification

Supplier may propose an alternative equivalent proprietary system for the false / cavity floor. The decision of the Engineer as to the acceptability or otherwise of the alternative system will be final and binding and in case it not being accepted the Supplier shall provide the false / cavity floor as specified.

10.21.30.10 Fire proof doors refer specification on fire proof doors.

